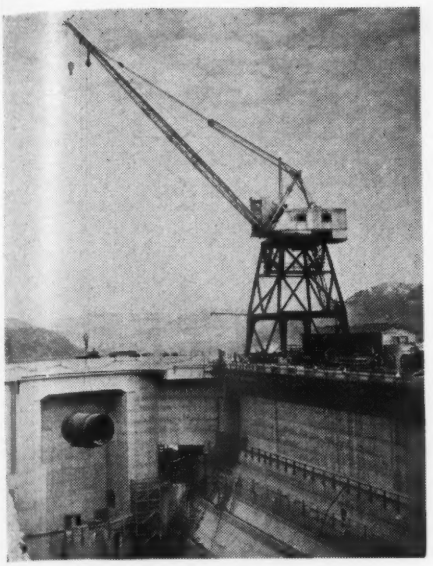

ON THE COVER

EARLY in March a crane lowered into the pumping plant at Grand Coulee Dam the first 20-foot section of 12-foot-diameter pipe through which water will start its journey in 1952 to irrigate 89,000 acres of land in central Washington. Eventually, ten of the largest pumps ever built will push enough water through twelve of these huge pipe lines, with a total length of 9000 feet, to grow crops on more than a million nonproductive acres in the Columbia Basin. The pipe, costing in excess of $1,000,000, is being placed by Consolidated Western Steel Corporation, a U. S. Steel subsidiary. Morrison-Knudsen-Peter Kiewit Sons' Company is the main contractor.

●

IN THIS ISSUE

THE often-told story of Leadville, Colo., is so colorful that it bears repeating. L. D. Anderson, author of the condensed history of the 89-year-old metal storehouse that starts off this issue, is a native of Leadville. Upon being graduated from the Colorado School of Mines in 1939 he engaged in mining there until a few months ago.

●

THE Humphreys family of Denver, Colo., has been prominently identified with oil production and metal mining for four decades. Its latest contribution to mineral technology is an ingenious spiral concentrating device. Page 91.

●

LIMA, the capital of Peru, is fortunately situated where it can draw upon the energy of rapidly falling Andes streams for electric power and is gradually developing the Rimac and Santa Eulalia rivers. The present Moyopampa Project includes the driving of 8 miles of tunnel. Page 94.

●

CORRECTION

ERRONEOUS figures were given in an item that appears on page 43 of our February issue and relates to drift-driving progress in Marieville Consolidated Mines, Ltd., of South Africa. The average daily advance should have been 47.2 feet, the average progress per round 8.3 feet, and the best daily advance 58.1 feet.

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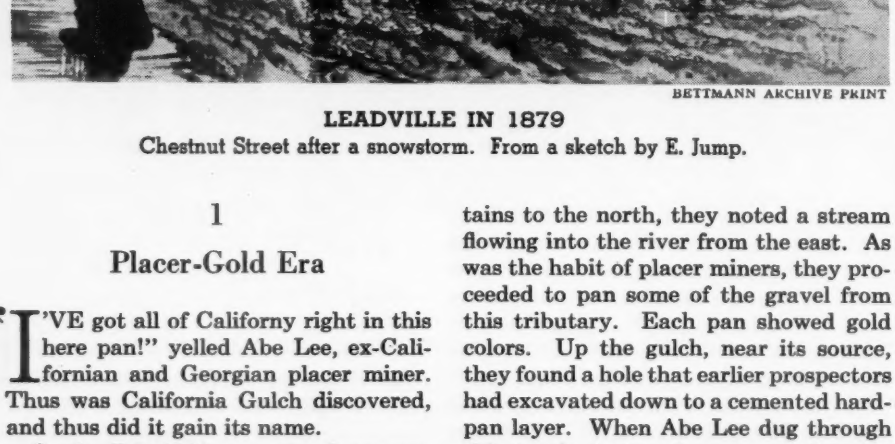
Leadville Through the Years

Colorado's Lofty Mining Camp Has Had Its Share of Fat and Lean

L. D. Anderson

HARRISON AVENUE IN 1948
Leadville's main street as it looked last December from Capitol Hill. Sometimes called the "Cloud City" because of its 10,200-foot elevation, Leadville gets plenty of snow and the Army trained World War II ski troops at nearby Camp Hale. The original name of Oro (gold) City gave way to the present one in 1878, by which time silver-lead ore had become the principal mine product. Two years later, when the first of three railroads reached town, 35,000 persons were living in the area, annual metal output was valued at $15,000,000, and Leadville was the world's greatest silver camp. Its accredited all-time mineral production is around $475,000,000, of which 90 percent was mined before 1925. The 1940 census gave Leadville a population of 4774, but it increased so much during the war that the Government spent $1,000,000 on housing. With lead and zinc in demand and miners scarce, 40 soldiers were furloughed to boost output. High prices reminiscent of the pioneer days returned, and six oysters on the half shell without cocktail sauce cost $1.50.



BETTMANN ARCHIVE PRINT

LEADVILLE IN 1879
Chestnut Street after a snowstorm. From a sketch by E. Jump.

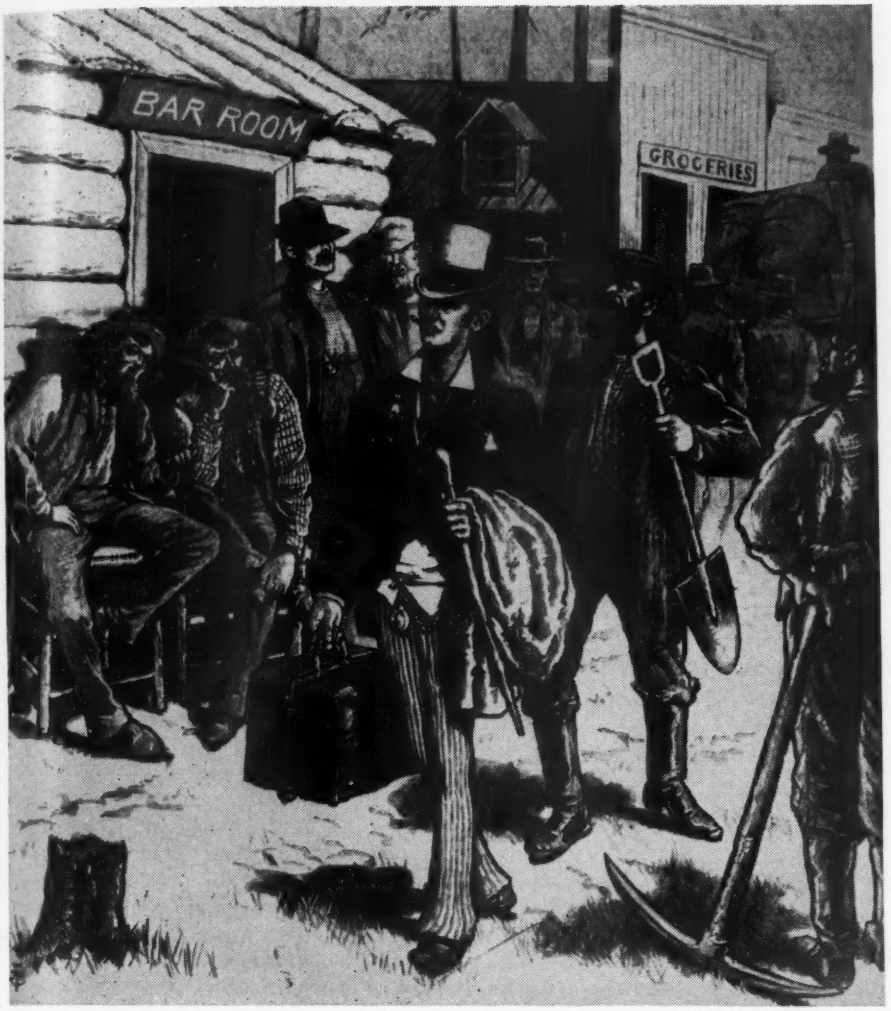
1
Placer-Gold Era

"I'VE got all of Californy right in this here pan!" yelled Abe Lee, ex-Californian and Georgian placer miner. Thus was California Gulch discovered, and thus did it gain its name.

On April 5, 1860, a party of prospectors discovered gold in a heavily wooded ravine high up in the Mosquito or Park Range near the headwaters of the Arkansas River. Those hardy pioneers had traveled from the Black Hawk and Clear Creek gold camps across South Park and up the Arkansas. While on their way to the lower Tennessee Pass in the mountains to the north, they noted a stream flowing into the river from the east. As was the habit of placer miners, they proceeded to pan some of the gravel from this tributary. Each pan showed gold colors. Up the gulch, near its source, they found a hole that earlier prospectors had excavated down to a cemented hardpan layer. When Abe Lee dug through this tough stratum he uncovered a rich gravel bed between it and the bedrock.

That's how gold was discovered in California Gulch, and so began the long history of the Leadville, Colo., mining district. This area soon outstripped most of the other early western camps, and to this day very few have outproduced it. Butte, Coeur d'Alene, Tri-State, and Bingham Canyon are among the regions that have yielded a greater monetary value of metals.

Within a week after the strike, the fourteen men that constituted the camp organized the California Mining District. They called a meeting and posted a notice, giving the time and place. That was done for the sake of legality, because all the folks in the gulch were camped on the same little flat. Abe Lee was made chairman, and a secretary was chosen. Lee, with the approval of the meeting, named three men judges of the election, and they appointed a clerk. By unanimous vote Mike Slaven became president; Zeke Thomas, because he could write, was elected recorder; Abe Lee, judge of the Miners Court; Billy Westcliff, sheriff; and H.A.W. Tabor, treasurer. The latter's job was more ornamental than useful, because the camp seldom had any funds. Here was a democracy, pure and simple. There was no such



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CONTRAST IN CLOTHES
The first "swell" arrives in camp. From an 1879 woodcut.

thing as representative government; every man took part, or had the right to take part, in the administration of the camp.

It is a curious fact that the laws passed by the different mining districts, however small and insignificant, have been recognized and made valid through subsequent legislation by Colorado and Acts of the Congress of the United States. Further, by the same high authorities, the judgments of the highest Miners Courts have been made as binding as those of the Supreme Court of Colorado or of the United States.

The first claims staked by the discoverers extended 200 feet up and down the gulch and were 50 feet wide. All later ones measured 100x50 feet. News of the richness of the placer traveled speedily, and soon 10,000 people had settled in the camp. They called their town Oro City. Its one street stretched 5 miles along the stream. It has been estimated that $2,000,000 worth of gold dust was washed out the first summer. Before long there were 6½ miles of continuous claims in California Gulch, 339 on the bottom and numerous others on the benches. Most of the mining was done by sluicing, but a claim was always worked first by panning.

To be a prospector in those days a man needed only a gold pan and a shovel besides his camp outfit. Digging into a likely looking gravel bed, he would scoop up some sand and gravel and drop it into the pan. When loaded, the latter was placed in water and the dirt stirred by hand to break up any lumps. After the larger stones were picked out, the pan was grasped in both hands and given a rotary motion. From time to time it was tilted and the surface layer of the material washed off. That was continued until a little black sand and gold, if any, remained. Then the sand was washed out, leaving the yellow metal.

Obviously, panning was slow, laborious work, and inefficient as well. Its virtures were cheapness and lightness of the equipment, for a man could carry it on his back. Once the presence of gold was established, more efficient methods were used. Boards were whipsawed from trees and fastened together to form a flat trough a foot or so wide and several plank lengths long. In the bed of the box were nailed small cross strips of wood between which was placed quicksilver whenever that material was obtainable.

Most of the placering in California Gulch was done by sluicing. Water from the ravine was diverted through the trough, and the pay dirt was shoveled in at the upper end. The gold, washed free of the sand and gravel by the tumbling action of the water, settled to the bottom, where it was caught by the quicksilver; the lighter waste material was carried away by the current. Because the camp's water supply was limited, it was used over and over again, and by the time it reached the lowest claim it was of the consistency of thin mud. Small wonder, though, after being used 300 and more times.

Why and how the gold came to be there never bothered the old-timers, but it is of interest to present-day miners. The gulch was gouged out 25,000 years ago at the time of the first glacial epoch. During subsequent glacial periods (10,000 to 20,000 years back) it furnished drainage when the surrounding icecaps melted. The runoff waters washed soft and loose rock and debris from the hill slopes into the bottom of the ravine, where the rock, that contained small stringers of gold, was rather deeply decomposed by the action of frost, water, and sun. The gold, which was not affected, was washed to the bottom of the gulch and concentrated there on the bedrock. It was the concentrate that the miners ran through their sluice boxes.

The only noted Coloradoans of the placer days that received recognition in the Leadville years that followed were Abe Lee, H. A. W. Tabor, and his first wife, Augusta. The Tabors ran the first store and post office in Oro City. Mrs. Tabor was both banker and doctor, and Mr. Tabor was very active in civic and mining affairs. He was lieutenant governor of Colorado from 1878 to 1885 and, later, United States Senator.

Life was not all roses in Oro City. Food was expensive, and the long wagon haul from St. Louis on the Mississippi River, plus the ever-present threat of raiding Indians, kept prices high. Passenger fare from St. Louis to Denver was $175 one way. The following list will give an idea of the cost of living in the camp in the summer of 1865:

Sugar, 100 pounds	$50.00
Flour, 100 pounds	25.00
Eggs, dozen	2.00
Butter, pound	70 cents to 1.00
Tea, pound	3.00
Coffee, pound	0.60
Canned fruits and vegetables, quart	1.00
Sardines, box	1.25
Rice, pound	0.50
Cornmeal, pound	0.25
Molasses, gallon	5.00
Onions, pound	0.65
Soap, bar	0.45

The working season in the gulch was short, for its elevation was better than

PHOTO BY C. H. KOCH

VESTIGE OF EARLY DAYS

Old picture of a log cabin, typical of the miners' abodes that followed the original tent city. The surrounding hills furnished adequate supplies of timber, and it was not long before sawmills were set up.

10,000 feet and near timberline. Winters were long, and little work could be done outside of the summer months and September and October. When the deep snows "came to stay," most of the miners went to milder climates and returned with the approach of summer.

As might be expected, gold dust was the universal medium of exchange, and it was kept in a buckskin pouch. In every store or saloon stood a pair of scales. When a miner bought a sack of flour or a glass of whiskey he "put his dust down" for the man behind the counter to weigh out the required amount and to hand back the remainder. As it came from the placer the precious metal was worth $18 an ounce; but the presence of silver, an impurity, reduced its value.

Some claims yielded more than $1000 a day, and one firm was said to have taken out $100,000 in about two months. Oro City's best year was 1861, when it produced $3,000,000 in gold dust. By 1866, California Gulch had been pretty well worked over and the population had dwindled to about half a hundred persons. The camp was "virtually dead" until June, 1868, when the first gold vein on the Printer Boy claim was discovered near the head of the gulch. A stamp mill was then built at Oro City to handle the ore from this and several other lode claims.

One of the last acts of the placer miners remaining in the camp was to pull down an old log gambling house and saloon to recover from its dirt floor more than $2000 in gold dust that had been dropped by careless or drunken patrons. When that was done, nearly everyone moved elsewhere, and the frightened game returned to drink from the stream from which $6,000,000 had been taken.

2

Lead-Silver Era

"THESE damn rocks are as heavy as lead." That remark was made a good many times during the gold days when Oro City instead of the later-day Leadville was the metropolis on the banks of California Gulch. Immense, weighty boulders were in the way when the gravel was shoveled into the sluices and had to be removed to reach the yellow metal under them. Another feature of this placer bar impressed itself unpleasantly upon all the gold seekers. Accumulations of heavy dark-red sand, which they found in the bottom of their pans and sluices at each washing, interfered with the settling of the gold and clogged the riffles.

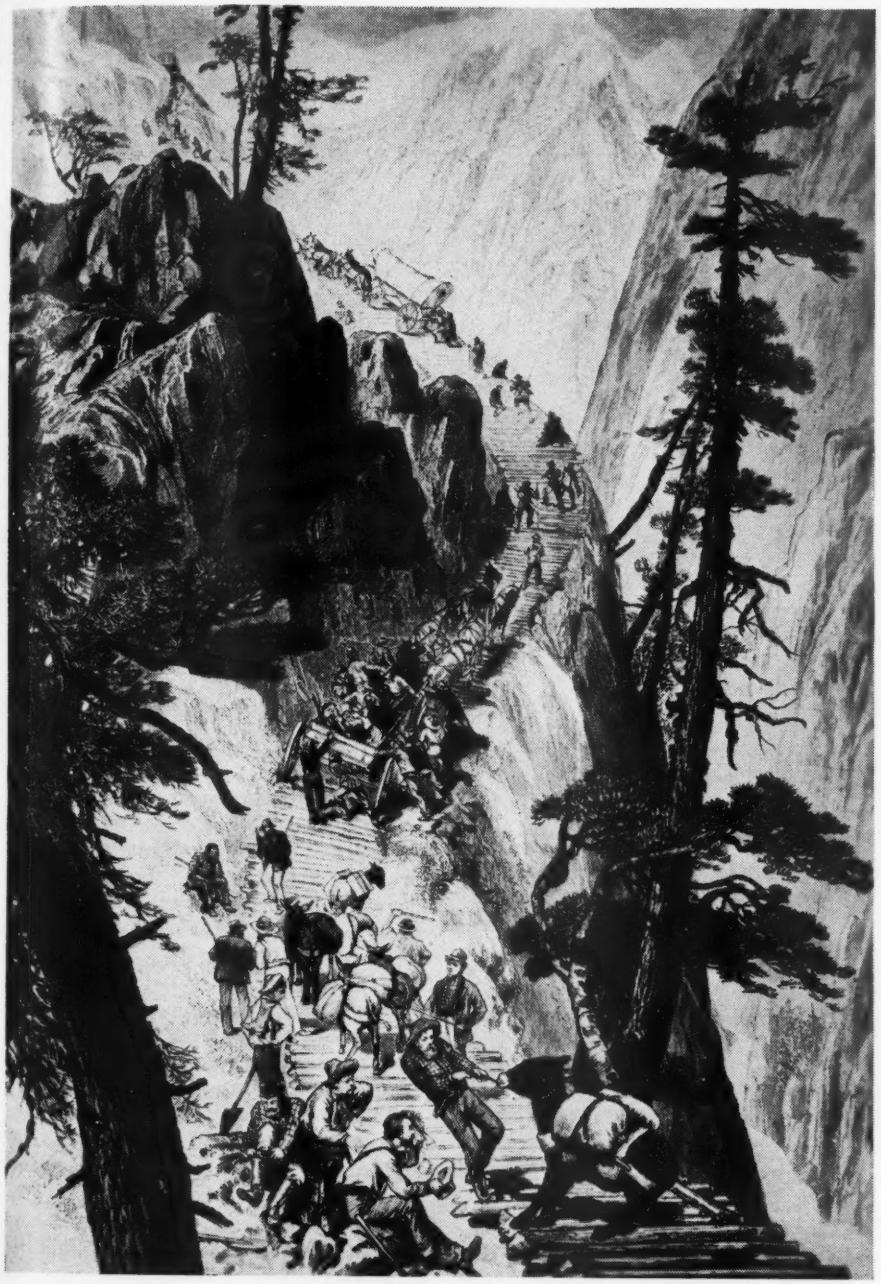
In the spring of 1874, "Woody" (A.B.) Wood and "Uncle Billy" (W.H.) Stevens had assays run on the heavy rock and red sands. They were the first to take this step, and thus learned that the two were mineralogically the same and rich in lead carbonates and silver chlorides. They began prospecting up the gulch for the source of the float and found a vein outcrop between the limestone base and the porphyry capping that was the summit of the hill. They made their discovery in June, 1875, on old placer claims that had one year to run before becoming invalid, so they kept quiet about it until they could stake the ground. The following summer they located nine claims along the vein. Their Rock Claim was later involved in a claim-jumping episode; their Stone Claim had a marked effect on the apex mining of the whole camp; and the Iron Silver, which in its day produced $20,000,000, was tied up in the courts for years.

Very rich ore extended downward from the surface, assays of material taken from the Rock Claim often showing from 600 to 800 ounces of silver per ton. In the summer of 1876, three hundred tons of ore was sent from Oro City to St. Louis for smelting. It cost $25 a ton to transport it by freight wagons to Colorado Springs, from where it was carried by rail to St. Louis at around $5 a ton. This shipment averaged only 7 ounces of silver but 60 percent lead and grossed about $92 a ton, with lead at seven cents a pound and silver at $1.16 an ounce. At today's prices of 21 cents

PHOTO BY C. H. KOCH

PROTOTYPE OF TABOR'S STORE

From the shelves of an establishment much like this one, and situated in the same area, Tabor provisioned the prospectors Hook and Rische while they dug a hole at the top of Fryer Hill that developed into the Little Pittsburg Mine.



BETTMANN ARCHIVE PRINT

ROCKY ROAD TO LEADVILLE

Although the artist undoubtedly mingled imagination with reality in this portrayal of an emigrants' train crossing 13,000-foot-high mountains to reach Leadville in 1879, the going was, in fact, far from smooth. From an engraving by E. Jump.

a pound for lead and 90 cents an ounce for silver it would come to approximately $235 a ton.

In the fall of 1876, following the erection of a lead smelter in lower California Gulch, Wood sold his interests for $40,000 to Levi Z. Leiter, partner in Marshall Field & Company—Chicago's huge department store that was first known as Field, Palmer & Leiter. This caused the camp to stir with renewed life, and the next year many other discoveries were made. The A. Y. and Minnie claims provided the stake upon which the Guggenheims built their tremendous fortune. Meyer Guggenheim purchased both from A. Y. Corman for $25,000 in 1881 and, together with his son Ben and Edward R. Holden, formed the Denver Smelter Company, Inc., and put up $50,000 for the construction of its first smelter in Pueblo, Colo., in January, 1888. During those seven years, when Charles H. Graham was in charge of the mines, better than $10,000,000 was taken out for the Guggenheims.

But the most important discovery around that time was made on Fryer Hill, where George Fryer had bought a prospect hole from "Chicken Bill" Lovell and struck low-grade carbonate ore. That was in the spring of 1878. It was then that H. A. W. Tabor rose to fame as one of the "Carbonate Kings," the rich mine owners of the early 80's in Leadville. Tabor had just moved his small store from Oro City to the new town of Leadville. More to get rid of them than in the hope of profit, he grubstaked two German prospectors, George Hook and August Rische, investing $17 worth of groceries for a third interest. Hook and Rische went up Fryer Hill to a spot beyond where Fryer was mining his low-grade carbonates. After drinking a jug of whiskey that had been included unknowingly in the grubstake, they decided that the site where they were camped was a good one for a prospect hole.

Strange to say, it was the only place where the ore deposit came anywhere near the surface, being only 26 feet below under a capping of porphyry. The contours of the ore and porphyry at the point of contact were like those of a stormy ocean. The waves and troughs were definitely outlined, and Hook and Rische sank on top of the highest billow. This little hill, which was only 40 feet above Stray Horse Gulch with never an outcropping or other indication of wealth a few feet below ground, was to become known at that time as the world's richest spot. The Little Pittsburg Mine, as the partners called their claim, was soon yielding an income of $150,000 a month from the lead-carbonate and silver-chloride ores that assayed from $150 to $300 a ton and were mined from a bed or flat vein 29 feet high. The Little Chief, a neighboring mine, at one time had an 80-foot vertical face of high-grade lead-silver ore

The foundation of Tabor's fortune was laid then and there on Fryer Hill, but its amount was to be increased in a singular way. Wholesale dealers, from whom he purchased supplies in Denver, commissioned him to buy them a promising claim. In accordance with the agreement, he purchased a new one for $40,000 from that somewhat notorious prospector "Chicken Bill." In his haste to make a sale, the latter didn't wait until his shaft had reached ore in place, but "salted" it with ore from Tabor's Little Pittsburg. He piled some on the surface and scattered some in the bottom of the hole. When the Denver men learned of the fraud they refused to accept the property, and Tabor was forced to keep it. He sank the shaft 20 feet deeper and hit ore. With Senator Jerome Chaffee and David Moffat as associates, he afterwards took out $1,500,000 and sold the claim as the Chrysolite for a like sum. Moffat subsequently distinguished himself by building a railroad across the towering Continental Divide. His dream to pierce it with a tunnel was fulfilled, but not in his lifetime.

The deposits were so rich and plentiful and easily mined that, except for parts of the Comstock bonanzas in Nevada, they surpassed anything previously found in the United States. Miners carried off tobaccocanfuls of ore and had

TWO TABOR MINES

Remnants of the former financial empire of H. A. W. ("Haw") Tabor, who parlayed a $17 "grubstake" into millions but died impoverished. The Little Pittsburg (right), so named because one of the partners, August Rische, had been an iron puddler in the Pennsylvania steel capital, gave Tabor his first riches. Shown below is the Matchless, reputedly Tabor's favorite mine. He bought it for $117,000 in 1879 and managed to leave it, although closed down and mortgaged, to his second wife, "Baby Doe" Tabor, upon his death. Following his advice never to part with it, she set up residence there and hung on to it doggedly, event to the point of defying court orders of eviction. The mine never came back into production and she died penniless.

silver buttons made for their coats and vests. Some made so much money selling their filched high grade that they didn't bother to call for their wages.

The ores from Fryer Hill were primarily responsible for the increase in mineral production from a total of $87,000 in 1877 to $2,500,000 in 1879. The peak output was $15,250,000 in 1882, and this was not exceeded until 1912. Like a rash, mines soon spread out from Fryer Hill to the south and east toward California Gulch. Carbonate Hill, at the southeastern edge of Leadville, became so covered with dumps of waste rock that there was talk at one time of restricting the mines. Most of the properties cribbed or riprapped their dumps to keep them within the claim boundaries. Otherwise, they would have covered the workings downhill and invited litigation.

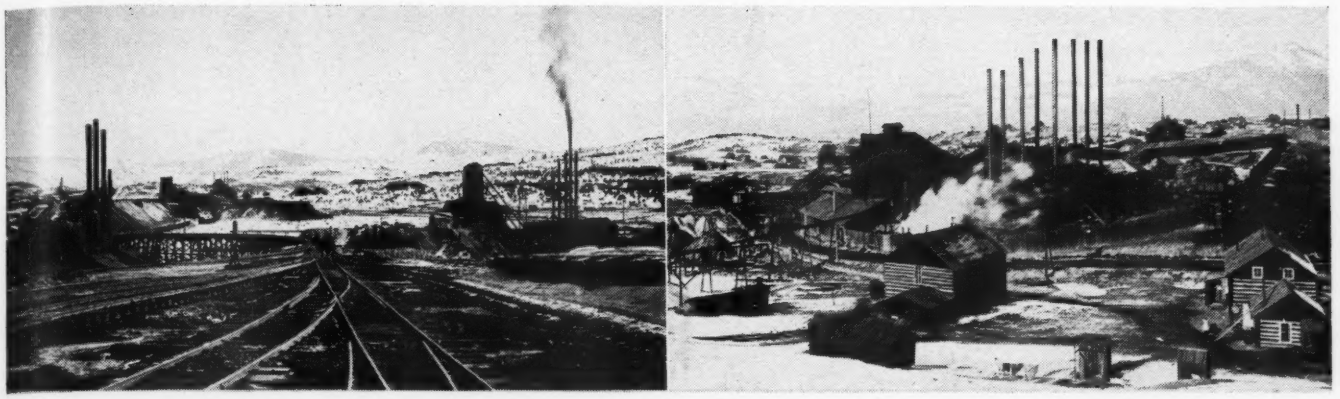
The Downtown Mines, a group name for properties within the Leadville city limits, faced legal problems involving rights to mine below the surface, conflicting claims concerning surface and mining rights, and the removal of waste rock. These problems, however, were a very negative factor in the westward migration of underground exploratory work. Harrison Avenue, Leadville's main street, seems to follow closely along the western boundary of the district's ore deposits. A few prospect holes were sunk west of this boundary, but no values except low-grade manganese ores were found.

With the rise in mineral output, Leadville's population jumped from 12,000 in the spring of 1879 to 60,000 six months later. By the end of 1879 some 30,000 claims had been staked. As can be imagined, there was soon a patchwork of claims overlapping and running across one another from every point of the compass. Everywhere was confusion and conflict, resulting in endless litigation, brutal murders, and private wars. The statement that "A well-stocked arsenal

LEADVILLE HERALD-DEMOCRAT PHOTO

NUCLEUS OF LEADVILLE

An old but undated picture of California Gulch in the general section where gold was discovered in 1860 and where new life was breathed into the expiring camp of Oro City by the recognition, in 1876, that the heavy black rocks that had plagued early placer miners were rich silver-lead carbonates.



MINES OF CARBONATE HILL

Two famous properties, the Mahala and the Greenback, are shown at the left as they appeared at the peak of production. At the right is a view of the Robert Emmet Mine showing the stockade that was erected during the strike of 1896 when 90 percent of the workings were inactive because of the demands for a base pay of $3 for an 8-hour day.

must be considered as essential to a producing mine as an engine or hoist," was a familiar one and generally acted upon. Colonel Stocking, a noted "gunman" with an effective fighting force of 50 men, guarded the portals of the Iron-Silver Mine day and night, while several brass cannons were mounted within the inclines and tunnels. Only in this way was the company able to keep "claim jumpers" off its property.

After a prospector had driven his stakes he had 60 days within which to start on his workings, such as a shaft or a tunnel. If he failed to do that, the claim could legally be jumped. Upon striking mineral, the miner had to have his claim officially surveyed and recorded. The lines could be carried in any direction so long as the discovery workings were located midway between the sides of the claim. This allowed an owner to run his survey right over the workings of neighbors who were near but hadn't struck ore, causing them to lose all their labors because absolute title belonged to him who surveyed first. Naturally, hard feelings resulted, and often "much to do" was made of such incidents.

Production of silver and lead continued steadily, and while metal prices and the richness of the ore decreased, tonnage increased. The Bland-Allison Silver Act of 1878 calling for a set coinage of silver bullion monthly did much to bring about the boom of 1879-80. Lead held fairly steady between 3½ to 5 cents a pound, but silver dropped from $1.278 a fine ounce in 1874 to $0.92 in 1889. A temporary impetus was given silver by the rapid rise to $1.17 an ounce through the Sherman Silver Act of August 1890. It was repealed in 1893. The bottom then fell out of the silver market, and the price dropped to 63 cents an ounce.

Based on the guaranteed output of bullion and the need of coke and supplies for twelve local smelters, three railroads —the Denver, South Park & Pacific, the Denver & Rio Grande, and the Colorado Midland—extended their lines into Leadville. The D. & R. G. ran the first train into the camp in July, 1880, and rails were soon laid to most of the mines.

By July, 1893, most of the lead-silver mines were shut down. People left the camp like rats forsaking a sinking ship. The railroads reported a great increase in passenger service, but it was all one way —out of Leadville. One ticket agent was seriously mauled when he suggested return tickets to a group of disgusted miners. But the camp regained its prominence in the present zinc era.

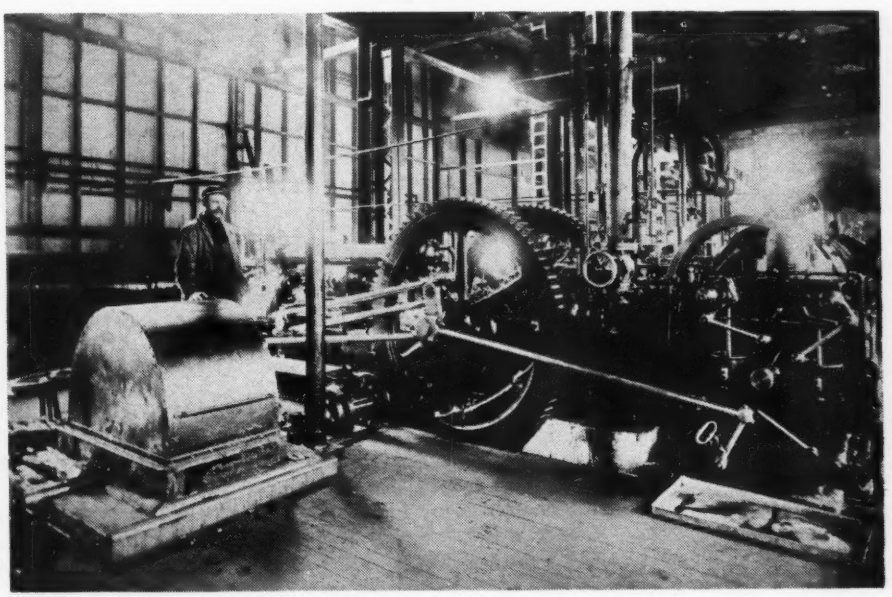
3

Zinc Era

"THEY'VE hit gold in the Little Jonny." That thrilling news spread like a forest fire through the Leadville District. Hard times, caused by the loss of the silver market, had bogged down most of the operations when John F. Campion and James Brown opened up a ledge of gold-quartz ore in 1893.

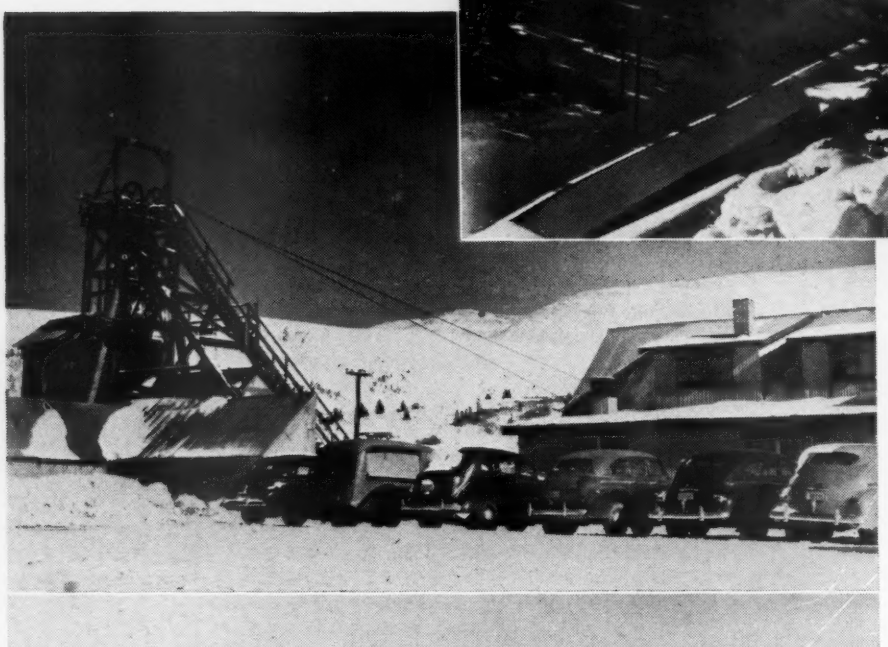
Sinking of the Little Jonny Shaft proved to be one of the most difficult undertakings ever carried to completion in the camp. It passed through quicksand, and to prevent the unstable ground from caving, heavy timbers were driven into it endways. Much credit is due Campion and Brown, who carried on their operations in spite of adverse conditions and pessimistic talk. Their success did much to revive the district and to give confidence to other mining companies. Within two years most of the lead workings were being reopened, but production was not up to the 1892 level.

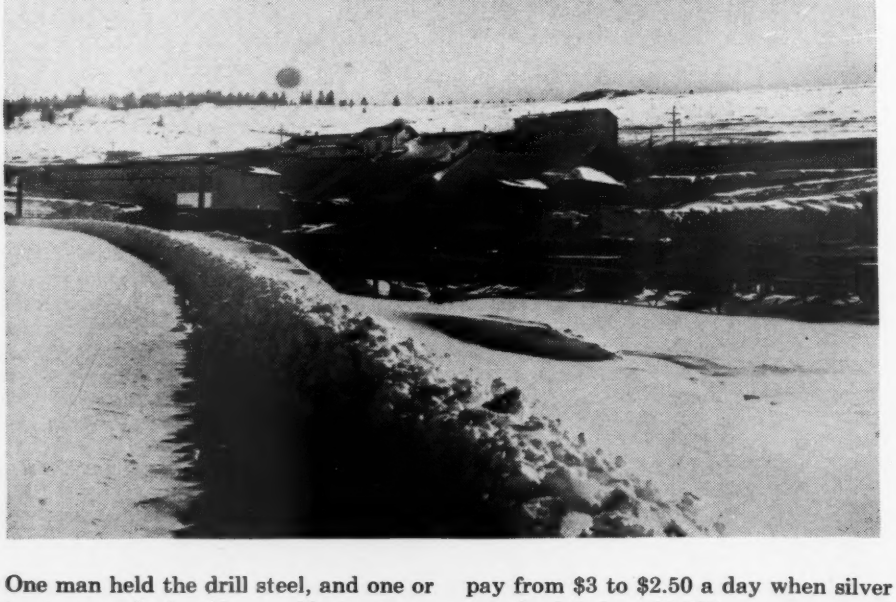
During that period, managements became more cost-conscious and concentrated their attention upon drilling methods. Until that time all underground drilling was double-jack work.



EARLY STEAM-DRIVEN COMPRESSOR

The location and date of this photograph are not recorded, but as rock drills did not come into general use in Leadville until shortly before 1900, there probably was little demand for compressed air before that time.





CURRENT OPERATIONS

Leadville's leading producer today is the Resurrection Mining Company, formed in 1939 by Newmont Mining Corporation, Hecla Mining Company, and U.S. Smelting, Refining & Mining Company. By means of the Yak Tunnel, shown at the right with a snowshed over haulage tracks angling up from the lower-left corner, it mines several properties, the principal one of which is the Resurrection No. 2 (below). Ores are treated in the Resurrection Mill pictured at the bottom.

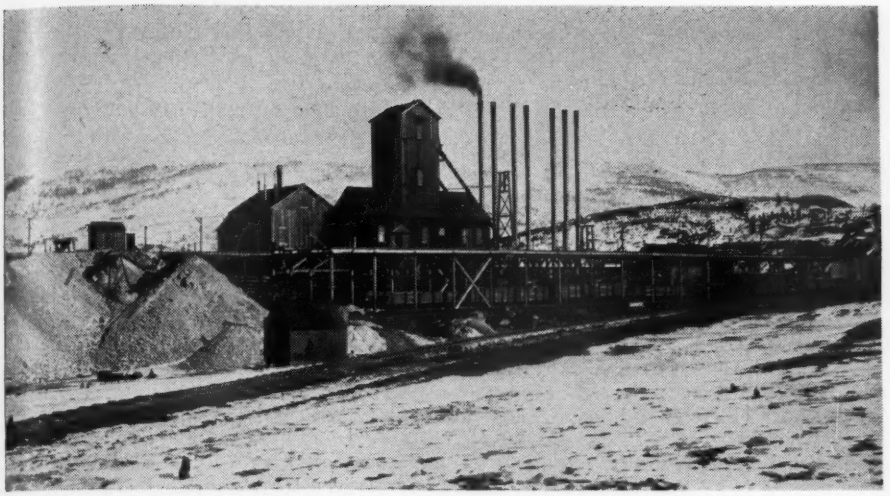
One man held the drill steel, and one or two men, swinging 10-pound hammers or double jacks, struck it rhythmically. The mine operators figured that footage could be increased and cost decreased by the use of single jacks. So each man was given a 4-pound hammer and a set of light steel. As a result of this change, production rose about 25 percent.

When output went up and wages didn't, trouble commenced. Workers wanted more money and shorter hours. In September, 1893, labor and management arrived at an agreement to reduce pay from $3 to $2.50 a day when silver remained below $0.835 an ounce, and when the metal sold for more than that for a calendar month to raise wages proportionately. Silver failed to reach that price again until after World War 1.

According to the best records available, the first air-operated rock drill in the Leadville district was the Ingersoll "Slugger," a dry piston-type machine used in the Moyer mines late in 1893 or early in 1894. Soon thereafter several second-hand drills were brought into the camp from the Buss Tunnel of the Colorado Midland Railroad. The men didn't like them, and that explains why they were often left near a blast or allowed to be covered by caving ground. The first air-driven machine of the hammer type with hollow drill steel for the passage of air and water was a "Leyner" drifter. A holiday was called by various mine managers to permit their workers to see that drill in operation at the Yak Tunnel heading in the spring of 1901.

As gold production rose, the camp recovered somewhat, and while most wages had gone back to $3 a day the men still worked ten hours. On June 21, 1896, ninety percent of the mines were closed by a strike for a base pay of $3 for an 8-hour day. Before long, the companies imported strike breakers from Missouri, and conditions became so threatening that several installed arsenals and employed armed guards. The buildings and shaft timbers of the Coronado Mine in the Downtown District were burned, and a number of strike breakers and the Leadville fire chief were killed. The strikers then attacked the Robert Emmet Mine, but were repulsed by the guards.

At that stage the State Militia was called into the camp. With the importation of new men, operations were gradually resumed and the strike was defeated in nine months. Its effects, however, were serious. Output of all classes



SCENE OF UNDERGROUND BANQUET

In 1910 the owners of the reactivated Wolftone Mine were so gleeful over the large zinc-ore bodies being discovered that they staged a banquet in one of the huge stopes to show it off.

of ore except high-grade gold fell off greatly, and most of the workings became flooded and filled with fine silt. Some of the mines were not reworked until 1908. That strike, and the one at Cripple Creek in 1903-04, brought about the demise of the Colorado Midland Railroad. Though it existed under a receivership until 1918, it never again was a paying proposition.

Another paying business, zinc mining, followed in the wake of those troubled times. Zinc ores were plentiful in the district; but, so far as anyone knew, only in the form of sulphide sphalerite. When found in combination with other metals, zinc was considered a detriment in the early days because it could not be saved in the process of smelting with gold, silver, copper, and lead. Since it also had a tendency to clog the furnaces, smelters imposed a penalty for treating zinc-bearing ores. But the invention of the Wilfley concentrating table in 1895 made it possible to separate the zinc on a commercial scale and to cast it out with the tailings.

By 1900, however, high-grade zinc-sulphide ore had found a foreign market, and its mining was a recognized phase of the camp's activities. Belgians bought the ore as cheaply as possible, freighted it to New Orleans, and shipped it to Brussels. By 1902, American plants had started buying zinc sulphides and soon put an end to the export business. It wasn't long before zinc output exceeded that of lead, and it has since topped all other metals in yearly value except in 1908 and 1921.

After the richer sulphides were worked out, the companies turned to lower-grade deposits. In 1908 it appeared as though that resource, too, would soon be exhausted. But the luck of Leadville held, and in the summer of 1910 tests proved the existence of zinc in unsuspected forms. Carbonates and silicates of zinc —smithsonite and calamine—were well-known minerals, but geologists, metallurgists, and miners had been walking through immense deposits of these ores in Leadville without suspecting their magnitude. There was little difficulty in selling the zinc ores, for the demand for spelter—the commercial name for impure zinc—was good. For several years it had a steady market as a base for certain paints because it prevented the appearance of the yellow stain caused by weathering.

The Maid of Erin, the Mahala, the Wolftone, and other famous early-day bonanzas were reactivated, and the district's largest ore bodies were discovered. So much were the owners impressed by their size that a banquet was held in one of the bigger stopes (the "Banquet Hall Stope" of the Wolftone) to celebrate a new zinc-mining era. When those rich deposits were exhausted, working of the low-grade ore was made possible mainly by building a tunnel to drain underground water and by better concentrating methods.

Drainage of the area was the purpose of one of Leadville's earliest projects. In 1886 a group of mine owners and citizens formed a company to drive the Yak Tunnel from the Arkansas River to the mines. The proposal called for a portal 5 miles west of and 581 feet below the present courthouse. Ground at the foot of California Gulch and near Malta was purchased, but operations were never begun. In 1895 the Yak Tunnel was started at the base of Iron Hill higher up in the gulch. This site was 180 feet above the courthouse elevation and was of no help to the Downtown Mines. The purpose of the bore was threefold: drainage, exploration, and development.

The tunnel was designed to penetrate the several ore bodies not once but a number of times, for each successive post-mineral north-south fault had raised the eastern-dipping sedimentary beds upward, proceeding in an easterly direction. Beginning in the white-porphyry capping, the Yak soon reached the first fault—the Iron—and then progressively cut the lower quartzite, the white limestone, the parting quartzite, the blue limestone, and the white porphyry again before arriving at the next fault, whence the order was repeated. The usual ore was a massive, granular mixture of sulphides, among which pyrite, galena, and sphalerite prevailed and occurred as limestone replacements near the porphyry contacts.

The tunnel was connected with neighboring mines for drainage and ventilation, services for which a small royalty was charged per ton of ore shipped. Originally, it was planned to carry it through the Mosquito Range to Alma,

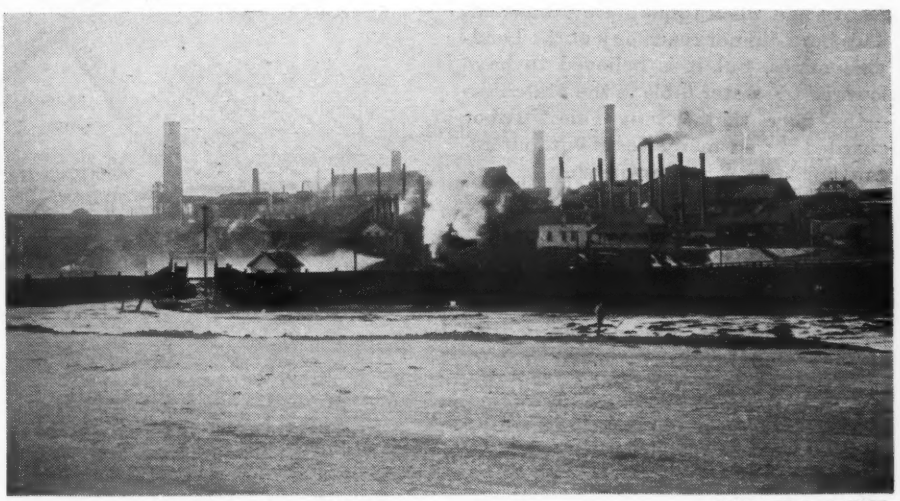
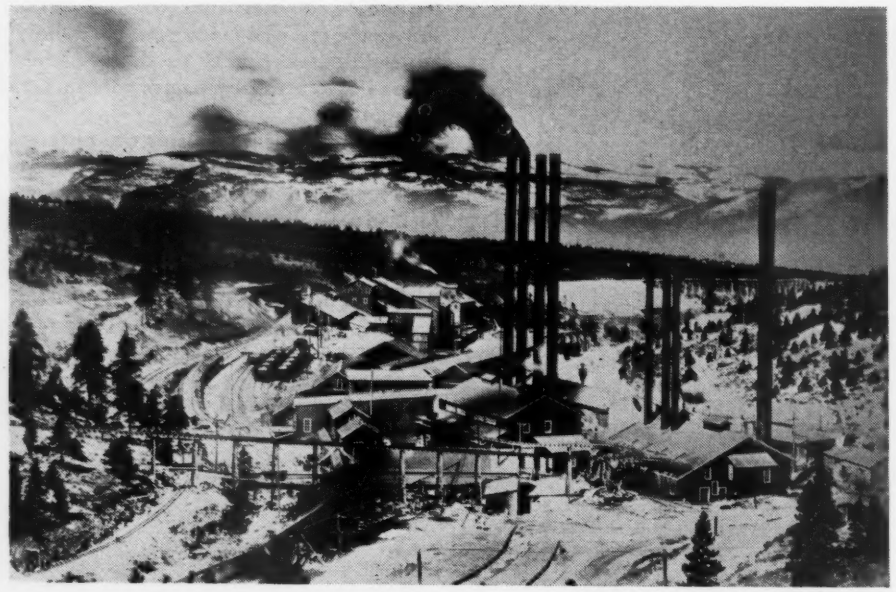


PHOTO BY C. H. KOCH

ARKANSAS VALLEY SMELTER

Last remaining plant of its kind in the district. It is operated by the American Smelting & Refining Company, the nucleus of which was established by the Guggenheims in 1881 with profits from the A. Y. and Minnie claims which netted them $10,000,000 in seven years.



COLORADO HISTORICAL SOCIETY PHOTO

YAK TUNNEL PLANT ABOUT 1909

Begun in 1895 as a drainage, exploratory, and development project, the bore was about 20,000 feet in when this picture was taken. Here the first "Water Leyner" rock drills to reach Leadville were demonstrated in 1901 to miners of the district, who were given a holiday for that purpose.

but by 1909, after fourteen years, it had been driven only about 20,000 feet, or just beyond the Resurrection No. 2 Shaft. It is still used for haulage, drainage, and ventilation.

The next drainage tunnel was the Canterbury Hill at the northeast edge of the district. It was to have tapped the Resurrection No. 2 Shaft 250 feet below the Yak Tunnel, but was discontinued before reaching its objective. In 1943 the U. S. Bureau of Mines started one about 2 miles down the Arkansas River from the Canterbury. It was supposed to have been driven 11,300 feet in 22 months for $1,400,000; but because most of it penetrated unstable ground that needed grouting and concreting, work was stopped when the heading was 6600 feet in and when funds were exhausted. This bore did not reach any of the Leadville mines, but it is believed to have lowered the water table in the Matchless —the mine that "Baby Doe" Tabor guarded for so many years without regard for laws of legal ownership.

And speaking of laws, there is a mining law in force in most camps that does not apply in the Leadville District by reason of adverse court decisions. This is the "Law of the Apex." Apex in mining is the highest point of a mineral vein or lode and does not necessarily mean an outcrop. According to the Revised Statutes of the United States for 1872, the owner of a mineral claim which includes the apex is allowed to follow that vein along the dip for an indefinite distance past his side lines regardless of ownership of the overlying surface so long as he stays within his end lines.

But in the Leadville District, the claim owner has rights only to the minerals that are found within the limits of his vertically projecting side and end lines. The Stone and the Iron Silver claims of "Uncle Billy" Stevens were on the apex of fairly flat blanket veins. If the law had applied in the district, it would have enabled the discoverer of those apexes to have followed the veins' sinuous courses indefinitely and thus practically monopolized the mineralized sections of Iron Mountain.

With all its laws, history, and peculiarities, the famous old camp still lives on among its high mountains and cloud banks. Like a man grown to sober maturity after a street-urchin existence and a rowdy hilarious youth, Leadville, since 1900, has had an uneventful life, except for an occasional bat thrown in—in fact, at times it has just vegetated. Now, it is again going through one of its better periods, with the Resurrection, various American Smelting & Refining Company mines and leases, and sundry private leasers active. In 1948 they produced gold, silver, lead, zinc, and copper worth $3,950,000, as against $3,292,914 in 1947. Four other metals—manganese, bismuth, tungsten and molybdenum—were obtained mostly as by-products and were low in value. The only smelter left in the district is the A. S. & R. Arkansas Valley, and three mills—the Resurrection, the John Hamm, and the A. S. & R. California Gulch—are working.

Unfortunately for the small or "poor" prospector, surface or shallow mining in the camp is a thing of the past. Today, with the increasing depth of the ore bodies and the need of pumping great volumes of underground water, only large companies are capable of carrying on mining operations.

UNFINISHED DRAINAGE TUNNEL

Estimating that from three to four million tons of zinc, lead, and manganese ores could be profitably mined if they were unwatered, the U. S. Bureau of Mines started work on a 3 1/3-mile-long drainage tunnel in 1943. The sketch shows its projected course and the length in feet of different sections. Because of difficulties encountered in penetrating unstable ground, all the appropriated funds were consumed by the time the heading had advanced 6600 feet. No further work has been done since then.

AT CLIMAX MOLYBDENUM COMPANY

Some of the 128 spirals that treat approximately 6000 tons of flotation-mill tailings a day for the recovery of tungsten. The spirals are mounted on a light timber foundation and occupy only 0.29 square foot of floor space per ton of material handled daily. Except for help in bagging, one man per shift runs the plant.

Concentrating Minerals in Cast-Iron Spirals

Simple, Ingenious Apparatus Effects Gravity Separation of Materials Much Like Nature Does It at the Bends of Streams

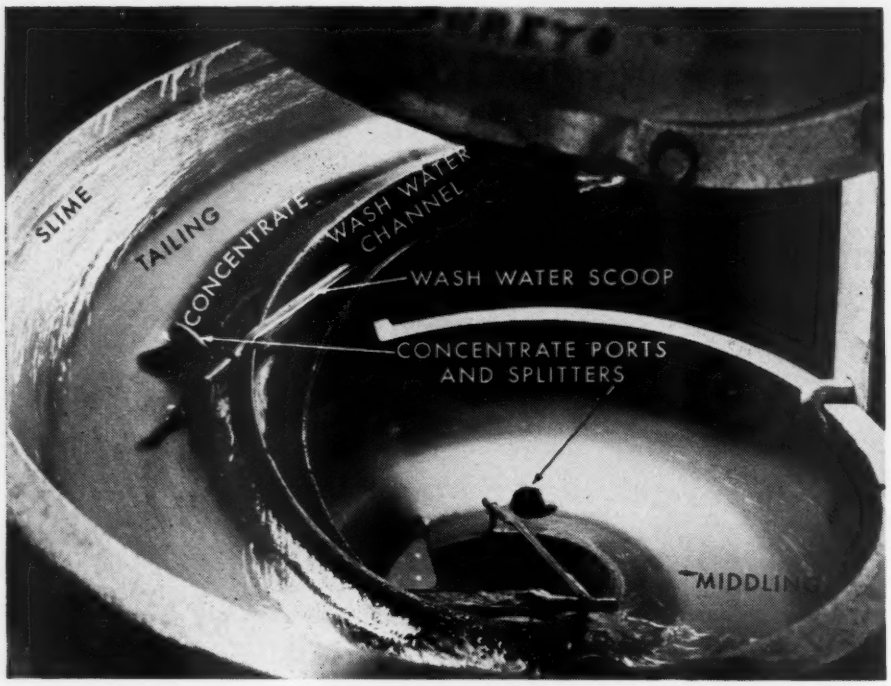
Walter P. Gillingham

MODERN mineral dressers have borrowed a trick from nature in the spiral concentrator. Rivers and streams carrying fine particles of gold and other valuable metals in suspension drop some of their load when rounding bends because the water nearest the inner bank flows at decreased velocity and permits the material to sink to the bottom. This action has long been known to prospectors, who have discovered many a bonanza in the sand bars at such points. Now, and in a similar manner, efficient, low-cost recovery of fine-sized minerals from sands, old mill tailings, and other sources is being effected in cast-iron spirals that simulate the concentrating action of a river bend.

The spiral concentrator was invented by I. B. Humphreys, president of Humphreys Investment Company of Denver, Colo., and is built by that concern. It is used for separating minerals of different specific gravities from fine material, generally minus 10 mesh, that is mixed with water to form a pulp. The latter is fed into the top of the concentrator, and as it rushes downward most of the upper layers of water and a large percentage of the lighter solids are thrown toward the outside rim by centrifugal force. The bottom layer of water, retarded by friction and therefore having less centrifugal force, slides sideways toward the inside rim, carrying with it the heavy particles that have sunk to the bottom. Wash water, introduced in a cross flow at the inner rim, sweeps outward over the band of heavy minerals to help remove any lighter particles that may be riding on top.

As a result of the concentrating action of the spiral, the feed is separated into three classes of material: a narrow band of concentrate containing most of the heavy minerals; a wider band of middlings consisting of a mixture of medium-heavy minerals; and a much wider band of tailings containing the light minerals. Concentrate and middlings are extracted from the bottom of the spiral trough through ports fitted with deflectors that can be rotated so as to take a narrow or a wide cut. Tailings are discharged at the end of the spiral.

The first commercial application of the Humphreys concentrator was made during 1943 by the Humphreys Gold Corporation to recover chromite mineral from the black beach sands of the Oregon coast. There, in seven months of operation, 30 spirals treated 183,500 tons of material containing on an average 6 percent of chromite. The yield was 42,843 tons of concentrate of a grade averaging more than 25 percent chromite, of which



CONCENTRATING ACTION OF SPIRAL

The heavier the material, the closer it hugs the inner rim. In this case, concentrate is being withdrawn at the upper port, while middling, being medium-heavy, moves toward the inner edge and is taken out at the lower port. When fine coal is cleaned, the refuse, being the heaviest component, is discharged and the coal follows the path marked "tailing."

from 92 to 98 percent was recovered.

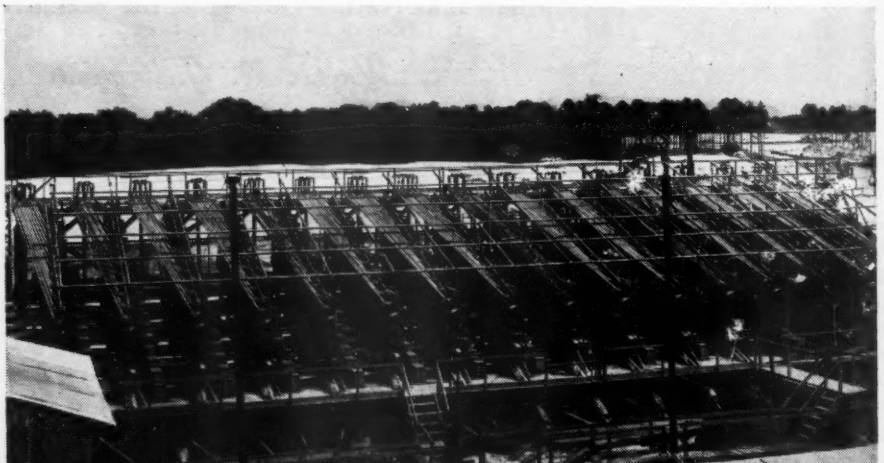
In 1944 the Oregon installation was dismantled and shipped to a site near Jacksonville, Fla., where the Humphreys Gold Corporation had acquired sand deposits owned by the Rutile Mining Company, which was engaged in the recovery of titanium minerals. The sand had been mined with draglines, washed and screened in a movable plant, and then concentrated by tabling and flotation equipment. The latter was replaced by the 30 spirals from Oregon and by 192 additional units which, combined, handled 5000 tons of material a day and produced a concentrate averaging 92 percent heavy minerals from a feed containing about 5-11 percent. Recovery of valuable minerals in the feed exceeded 95 percent. The plant has been enlarged in the meantime and today numbers 376 spirals treating 7500 tons a day.

Concentration is effected in three stages, with 252 spirals in the first or rougher stage, 48 in the second or cleaner stage, and sixteen in the third or finisher stage. Two tanks of inverted pyramidal shape are used to mix the pulp to the proper consistency. One receives the product of the washing plant and the other the concentrate of the rougher stage. In each tank are two concentric vertical pipes that terminate just above the pointed bottom and through which the material is fed to the spirals. Water pumped down through the inner one agitates the solids that have settled on the bottom of the tank, and a suction pump withdraws the mixture through the annular space between it and the outer pipe.

To obtain satisfactory spiral performance, the density of the pulp is controlled by means of the inner pipe, which is arranged so that it can be raised or lowered by manipulating a hand winch. Moving it downward increases the density of the material withdrawn from the tank; moving it upward decreases it. Delivery of the pulp to the multiple spirals is accomplished by the use of distributor heads and branching lines that split the flow from the tank into many uniform streams.

Concentrate emerging from the first-stage spirals goes to the second-stage feed tank; middlings are sent back to the first-stage tank for another trip through the rougher stage; and tailings are wasted. In the case of the second-stage spirals, concentrate flows by gravity to the third-stage spirals, while middlings and tailings are returned to the second- and the first-stage tanks, respectively. Tailings from the third-stage spirals go to the second-stage feed tank and the concentrate is delivered to a drying and separation plant where rutile and ilmenite fractions are recovered by electrostatic and electromagnetic methods. The resultant tailings pass through 60 additional spirals, and the concentrate they yield is dried and treated in more electrostatic and electromagnetic separators to extract the zircon content.

Many operating economies may be effected by the use of Humphreys spirals. They have no moving parts and therefore require no power except that for pumping and circulating the pulp. Floor space occupied is small in proportion to capacity. Heavy concrete foundations are unnecessary because there is no vibration and the weight of the units is moderate. Their operation calls for the services of but few men, the installation of 376 spirals requiring but three per shift. As to the water needs, each spiral uses 20-25 gpm., including 2-5 gallons of wash water. In the Florida plant the water is reclaimed so that only 2000 gpm. of make-up water has to be supplied for



RECOVERING TITANIUM AND ZIRCON

Since 1944, Humphreys Gold Mining Corporation has been treating sand near Jacksonville, Fla., for the recovery of the titanium-bearing minerals ilmenite and rutile. In recent years zircon also has been saved. Close to ten million tons of material has been handled. The picture shows 192 of the 252 spirals which constitute the first-stage unit.

HUDSON COAL COMPANY PLANT

At its Powderly, Pa., colliery, Hudson Coal Company is using Humphreys spirals to recover fine coal from breaker refuse for use under its own boilers. During the day shift they are fed wash water from the breaker; on the other shifts they treat material drawn from a 1,500,000-ton pile of silt accumulated during the past 50 years. Last year, during 363 shifts, the plant produced 116,350 tons of fuel at a power cost of around two cents a ton.

the 7500 tons of material treated each day.

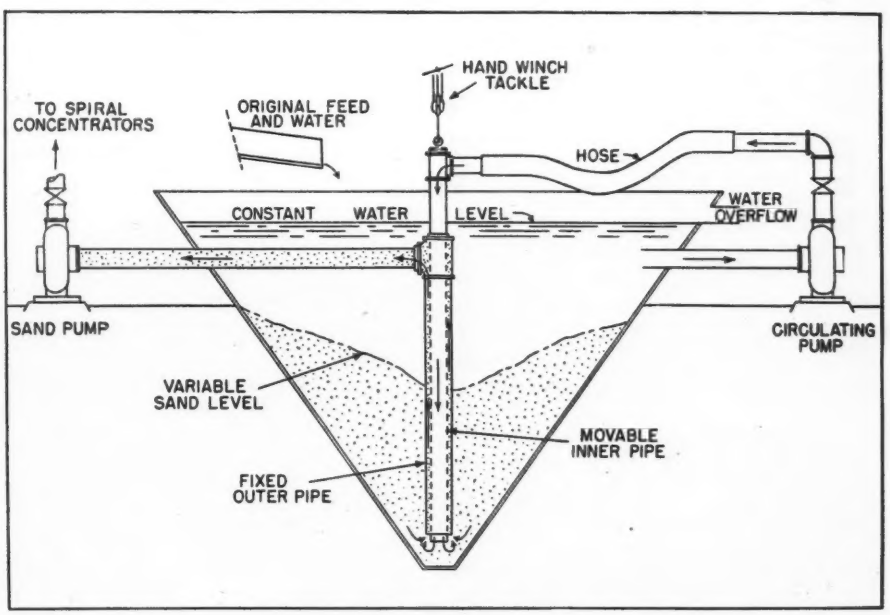
One big advantage of the spiral concentrator is that the flow of the stream can be changed considerably without affecting either recovery or the grade of the concentrate. Such variables as density, shape or size of particles, quantity of head feed, etc., may fluctuate widely and yet have no effect on the operation of a properly adjusted spiral. When the tonnage of the feed is to be reduced appreciably, all that is necessary is to shut down a proportionate number of spirals by closing valves in their intake lines.

Test runs with various minerals have shown the concentrator to be suitable for handling fine coal, both anthracite and bituminous, iron-ore washer tailings, lead-zinc-gold-silver ores, tungsten ore, tin ore, vermiculite, phosphate fines, ores of mica, etc. Several companies have installed spirals in the form either of pilot or full-scale concentrating plants, and results reported by them have been encouraging. A case in point is the battery of eight 3-turn units at the Leadville mill of the American Smelting & Refining Company. These spirals treat various ores to recover pyrite for use in the smelting operations. Another installation of recent date is that at the Piney River, Va., plant of the American Cyanamid Company that serves to condition ilmenite flotation feed. And closed-circuit units have been set up in technical schools, universities, and most of the regional laboratories of the U. S. Bureau of Mines for test purposes.

Climax Molybdenum Company, Climax, Colo., utilizes spirals as a rougher stage in the treatment of flotation-plant tailings for the recovery of tungsten. About 9000 tons are deslimed daily in Akins classifiers, and the product is delivered to 128 units that treat approximately 6000 tons of minus 48-mesh tailings each day. The concentrate goes to flotation cells for the removal of pyrite, then to Wilfley tables where some of the remaining heavy minerals are removed. The table concentrate passes first through wet-type magnetic separators, where fragments of iron picked up in the ball mills are eliminated, and then to dry-type magnetic separators where the final tungsten concentrate is obtained. Except for occasional help in bagging the finished product, one man per shift runs the entire plant.

The Hudson Coal Company, located in the Pennsylvania anthracite region, is operating spirals for the treatment of anthracite silt. The possibility of recovering fine-sized coal for use as boiler fuel from a bank of some 1,500,000 tons of silt at the company's Powderly Colliery, and the need of preventing further accumulations from breaker wash water, led to the installation of a pilot plant made up of three spirals—two first-stage and one second-stage. Following successful tests, 48 six-turn units were put in service in the spring of 1947. They are on a 3-shift-a-day schedule during nonfreezing weather, providing fine coal which is burned on specially designed traveling grates in the company's powerhouse.

From March 15 to December 1, 1948, operating 200 day shifts and 163 night shifts, the cleaning plant produced a total of 116,350 tons of fuel containing 16.5 percent ash from feed having an ash content of approximately 30-35 percent. During the day the spirals treat breaker waste water, during the other shifts they are fed material from the silt bank by a scraper system. One man per shift does most of the work involved, and power costs have been kept in the neighborhood of two cents a ton of fuel produced. The company is now building a second plant of 40 spirals at one of its other collieries.



FEED AND DENSITY CONTROL SYSTEM

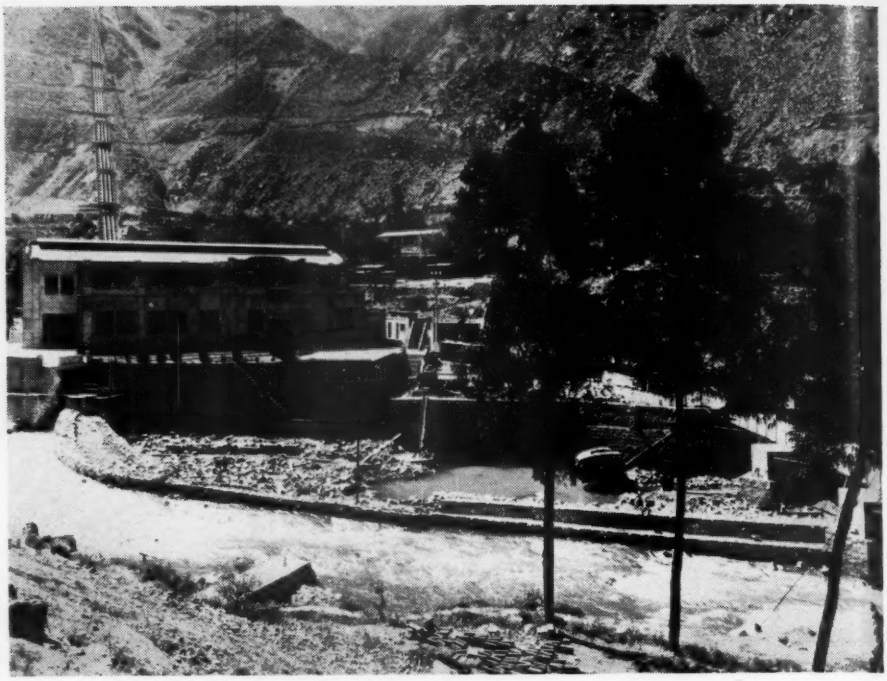
The density of the material fed to the concentrators can be increased or reduced by respectively lowering or raising the inner water-delivery pipe. Movement of the pipe is effected by means of a hand winch. The feed is drawn up through the annular space between the two vertical pipes by suction induced by a sand pump and is delivered to multiple spirals through distributor heads and branching lines.

More Power for Lima, Peru

Moyopampa Project in Andes Includes 8-Mile Tunnel. Generator Turbines Will Run Under 1550-Foot Head.

*William Bellano**

PHOTOS BY H. R. RAMUS



INTAKE WORKS UNDER CONSTRUCTION

Water from the tailrace of the Juan Carosio power plant (note penstocks leading down to it) will enter a tunnel underneath the riverbed. Intake structures will include sand traps and regulators.

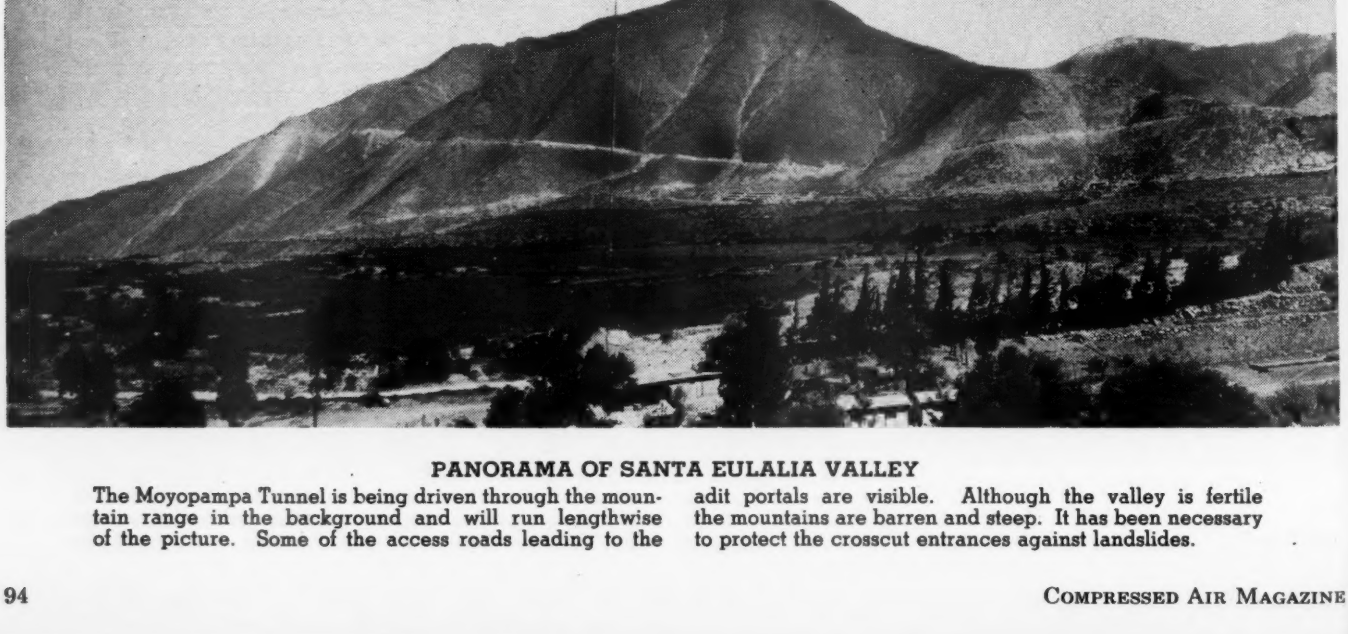
ELECTRIC power requirements of Lima, Peru, are increasing at the rate of 11 percent a year as against an average of 7 percent for most large cities. This is attributable to an abnormally rapid growth in both population and industrial activity in the metropolitan area. To keep pace with the trend, the local utility, Empresas Electricas Asociadas (Lima Light & Power Company) is adding 60,000 hp. of hydroelectric generating capacity to its system through works now underway near the town of Chosica, 25 miles northeast of Lima.

*Assistant General Superintendent, Volcan Mines, Ticlio, Peru.

The project is one step in a long-range program that is designed to exploit the power potentialities of the Rimac River and its tributary, the Santa Eulalia. These streams rise at an elevation of almost 16,000 feet and drain the western slope of the Andes Mountains in central Peru. They are relatively short because the range practically abuts on the Pacific Ocean in that region.

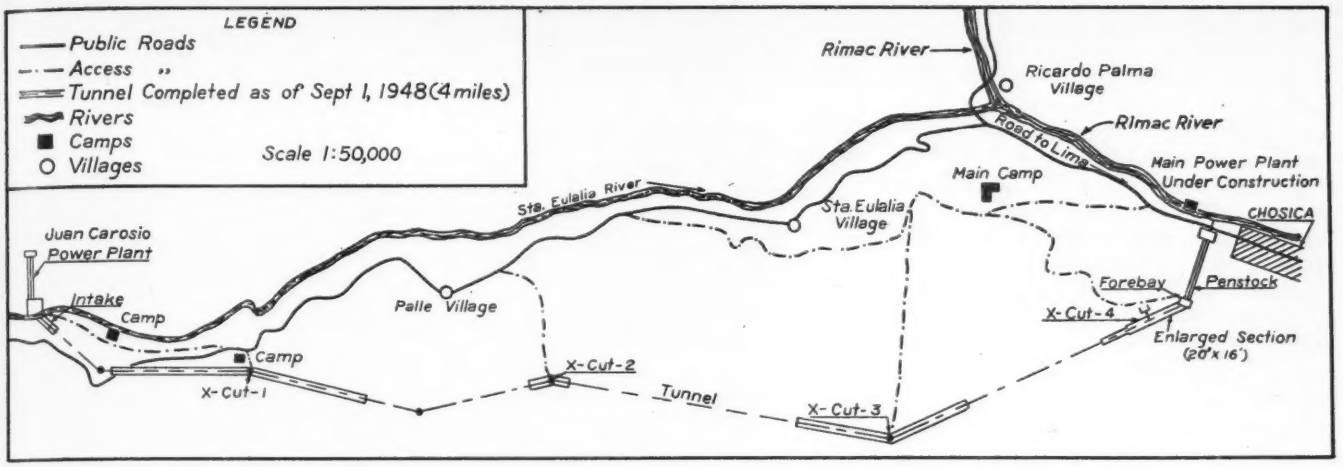
Four generating stations with an aggregate capacity of 93,500 hp. are already operating on this river system. Three of them are downstream from the junction of the Santa Eulalia and the Rimac and the fourth is on the Santa Eulalia above the confluence. The Salto Moyopampa Project, with which this article is concerned, will also use water from the last-named stream. So, too, will the Salto Huinco Project, which is on the program but scheduled for future construction. Incidentally, the latter's turbines will operate under a head of nearly 4000 feet. After the potential-energy output of the Santa Eulalia has thus been completely developed, the capacity of two of its plants will be increased by diverting water to them through a 12-mile tunnel from the Rimac River. As shown in an accompanying table, an ultimate capacity of 353,500 hp. will be available when all these steps have been carried out.

To facilitate financing and adminis-



PANORAMA OF SANTA EULALIA VALLEY

The Moyopampa Tunnel is being driven through the mountain range in the background and will run lengthwise of the picture. Some of the access roads leading to the adit portals are visible. Although the valley is fertile the mountains are barren and steep. It has been necessary to protect the crosscut entrances against landslides.



GENERAL LAYOUT OF MOYOPAMPA PROJECT

Course of the 8-mile tunnel, from the lower (right) end of which the water will drop through penstocks to the powerhouse turbines. Excavation of the tunnel is being expedited by driving in opposite directions from four intermediate points of access indicated by crosscuts or adits. This permits working eight faces simultaneously.

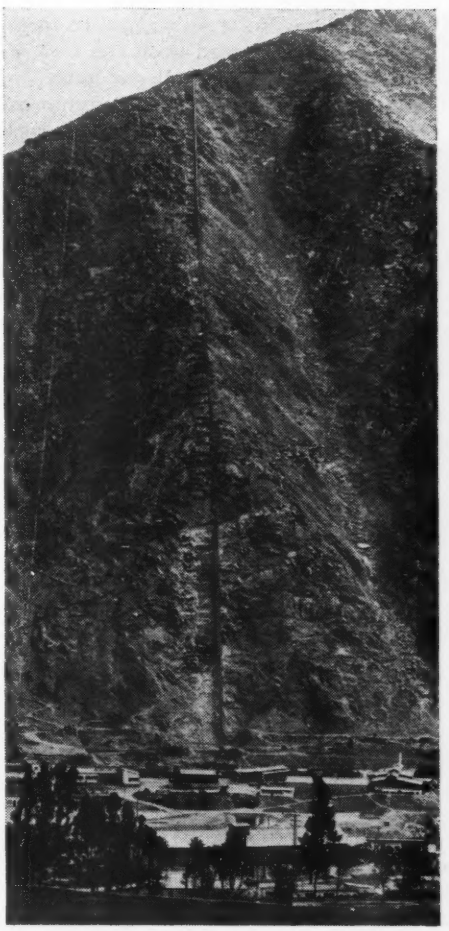
trating its plant improvements, Empresas Electricas Asociadas some years ago formed a separate operating company, Energia Hidroelectrica Andina S. A., more commonly called Hidrandina S. A. All the works undertaken since 1926 by the parent and subsidiary concerns have been designed and engineered by Motor Columbus, a Swiss firm, under the direction of its Peruvian representative, P. Boner. The Moyopampa Project is being built under contract by the construction firm of Christiani & Nielsen of Copenhagen, Denmark, at an approximate cost of $7,500,000. It is scheduled for completion by 1952.

Water will be taken from the Santa Eulalia River just below the existing 51,000-hp. Juan Carosio power station and conducted through 8 miles of tunnel to a forebay. From there it will flow into steel penstocks in which it will drop a vertical distance of 1550 feet to the powerhouse turbines. For the present, two penstocks, each 4 feet in diameter and 2500 feet long, will be provided. Later, when the proposed 12-mile tunnel is driven to divert water from the Rimac River, a third penstock of the same dimensions will be added and the generating capacity of the plant increased from 60,000 to 90,000 hp.

The Moyopampa Project was started in January, 1947, with the construction of the contractor's administration buildings in Chosica. Preliminary work involved erecting and equipping machine, carpenter, electrical, and rock-drill repair and sharpening shops, a compressor plant, and housing for workmen. More than 10 miles of single-lane roads also were constructed to give access to the different working sites.

To expedite driving the 8-mile tunnel, the line has been divided into four sections, with an approach adit at the approximate center of each one. Within convenient reach of the portals of these entryways, which are about 2½ miles apart, have been established camps complete with kitchen and mess hall, as well as a commissary that supplies basic necessities at cost. To reduce the number of living quarters to a minimum, provisions were made for single men only, and most of the labor is of that status. However, any worker desiring to build a rude house for his family can obtain the essential materials from the company without charge. As a result, auxiliary "shanty towns" have grown up around some of the base camps. Approximately 1500 men are employed.

For 6 miles from its upstream end, the tunnel will be 9x12 feet in cross section. In the remaining 2 miles to the forebay outlet it will gradually increase to 20x16 feet. The grade is 2¾ inches per 1000



PENSTOCK LINE

Here the water will drop 1550 feet to turn turbines in a powerhouse to be built in the foreground. The heavy vertical line is a service railway flanking the penstock route, where excavating is in progress preparatory to placing masonry foundations on which the 4-foot-diameter steel pipes will rest. Cars are raised and lowered by an electric cable-drum hoist at the mountain top. Two penstocks will be provided now and a third will be added when water diverted from the Rimac River will permit increasing the capacity of the station.

LIMA'S LONG-RANGE PLAN OF HYDROELECTRIC DEVELOPMENT

Power Plant	Capacity (Horsepower) In Operation	Under Construction	Proposed	Ultimate Total
Santa Rosa	30,000			30,000
Yanacoto	8,000			8,000
Chosica	4,500			4,500
Moyopampa		60,000	30,000	90,000
Juan Carosio	51,000		30,000	81,000
Huinco			140,000	140,000
Totals	93,500	60,000	200,000	353,500

feet, or about 14½ inches per mile. In driving the bore, two faces are being advanced in opposite directions from each adit intersection, making a total of eight points of attack. Tunneling was begun on June 20, 1947, and the south heading from Adit No. 4 was holed through on February 17, 1948. Each section is operated as a unit, independent of the others, and has been opened up as the necessary supplies and equipment have become available. The advantages and time savings possible by thus subdividing the job have not been fully realized because of a lack of facilities, and at present (January, 1949) only two units may be considered to be fully equipped.

The formation penetrated is predominantly granodiorite, with some conglomerates and decomposed zones that sometimes require support. Rock bursts, attributable to high internal pressure, have occurred frequently in the south heading from No. 3 Adit. In such cases, excavating is stopped until the area affected has been lined with concrete. No injuries to workers or losses of equipment have so far been sustained from rock bursts, and little water has been encountered.

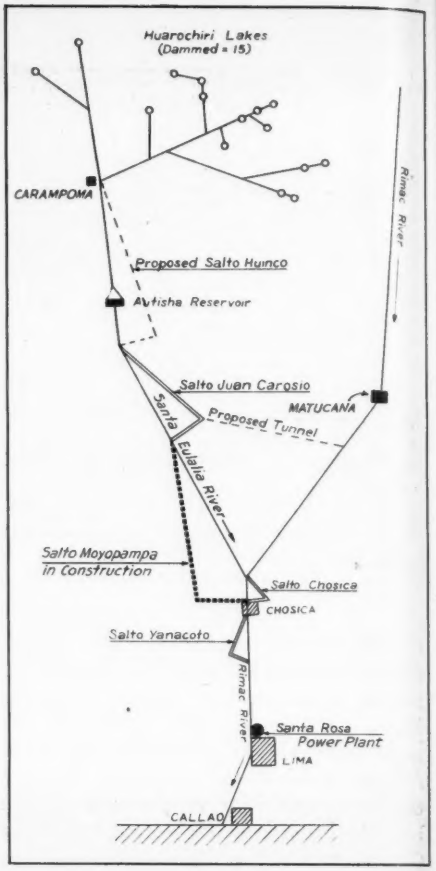
Conventional tunneling methods are being practiced. Each section has a drill carriage and a rocker-type 10-cubic-foot shovel that are transferred back and forth to serve the opposing faces. Drill carriages are patterned after the one used a few years ago in the Carlton Tunnel in Colorado, and on each are mounted four 3½-inch-bore power-feed drifter drills. Underground haulage is done with battery-type electric locomotives and rocker-dump cars of 27- and 36-cubic-foot capacity, there being 120 of the latter. Three-ton diesel locomotives do the hauling and switching on the surface and also go into the tunnels for distances not exceeding 300 yards. All track is of 24-inch gauge and is made up of 25-pound rails laid on steel ties. Muck cars are run up to the face by a switching track, which is generally moved forward once a week.

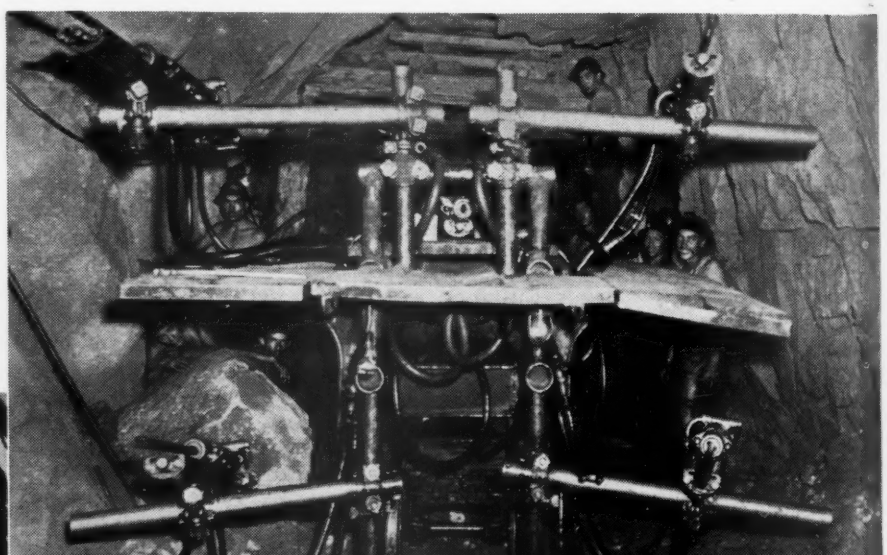
Water for drilling comes from the river below and is pumped against a head of more than 1000 feet to reach some of the points of use. It is piped to each heading in a 2-inch line. Each heading is independently ventilated by an Ingersoll-Rand 20-hp. motor-driven blower that delivers 3000 cfm. of air through a 16-inch line. Air is forced to the face during the drilling period and exhausted after each blast.

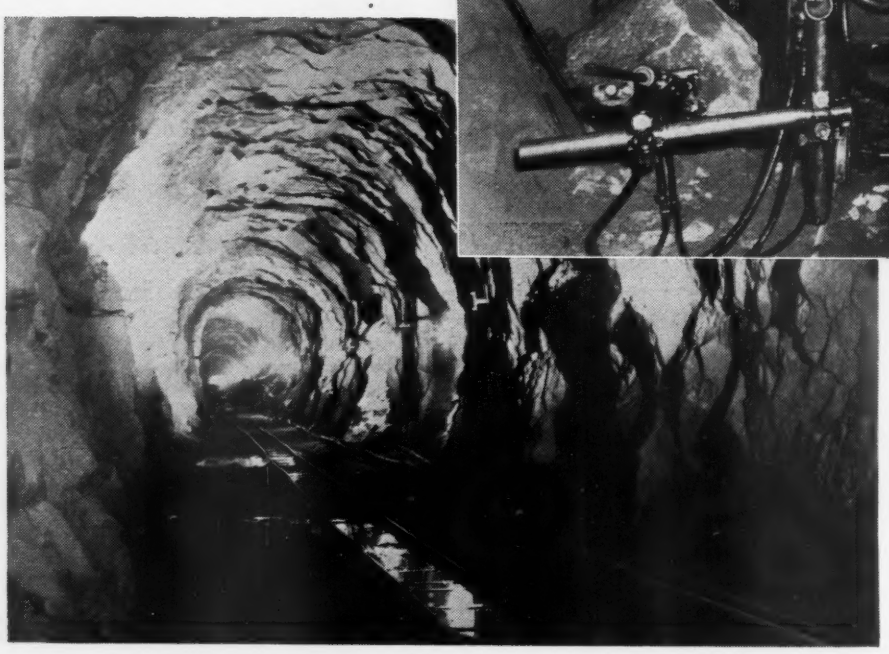
The 9x12-foot tunnel section is excavated full face, and a standard drilling round consists of 20-24 holes 8 feet deep. Until recently all drilling was done with Ingersoll-Rand Type 2 Jackbits on 1¼-inch hollow, round Jackrods. Now a

LIMA'S POWER PLAN

Drawing shows interrelation of the various steps which will ultimately harness the Rimac and Santa Eulalia rivers to produce 353,500 hp. of electric energy. Double lines indicate units already in operation. The Moyopampa Project is shown by heavy broken lines and proposed developments by light, broken lines. Flow of the Santa Eulalia has been stabilized by creating the fifteen Huarochiri Lakes near its headwaters.





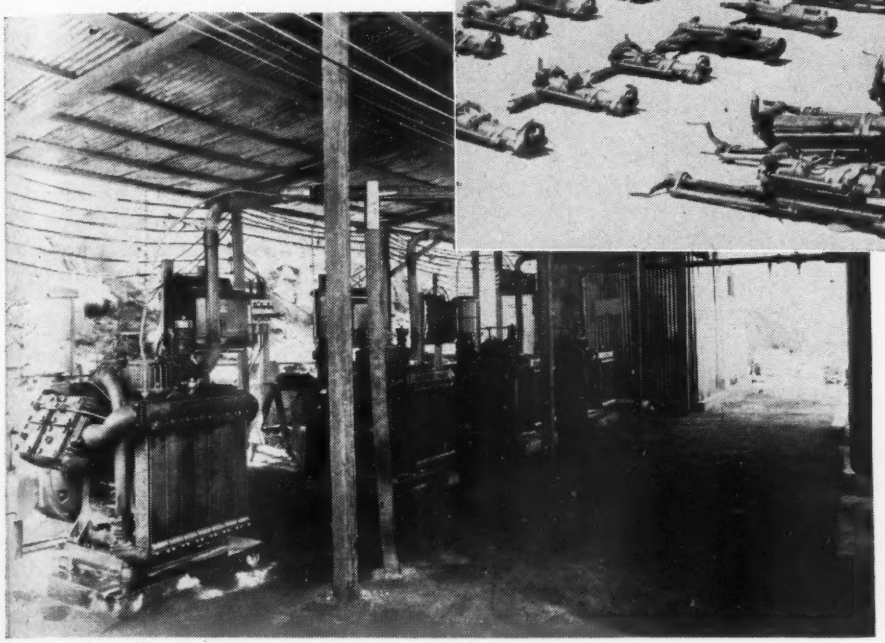


TUNNEL SECTION AND DRILL CARRIAGE

At the left is a section of the tunnel near the discharge end enlarged to full 20x16-foot size. Above is a head-on view of one of the four drill carriages showing the four drifter drills mounted on column arms.

COMPRESSOR STATION AND ROCK DRILLS

One of the four duplicate compressor plants, below, that furnish air power for tunnel driving. It consists of four Ingersoll-Rand 350-cfm. machines. In the view at the right J. Waerum, job superintendent (center), and J. Beck, chief mechanic (right), are shown with some of the Ingersoll-Rand drills that have been brought out of the workings for periodic inspection and cleaning.



shift is being made to the newer I-R Series 13 bits that are attached to the rods with stud-type connectors. Starter bits are 2 inches in diameter, and a reduction in gauge of $^1/_{16}$ inch is made with each progressive change as a hole is deepened. By resharpening bits, each one is used five to six times before it is discarded. As about 2 feet is drilled with each use, the total hole put down per bit is 10-12 feet. Blasting is done electrically with Gelignite of 90-, 62-, or 42-percent strength. Each shot advances the tunnel between 6 and 7 feet, breaking about 5 cubic yards of rock per linear foot. Overbreak averages 20 percent.

The operating cycle is divided into the following steps: haul in drill carriage and drill out round; move carriage to opposite face and load and blast; after a 30-minute interval to clear heading of smoke and gas, tram mucking machine from other face and muck out; lay track; extend air, water, and ventilating lines. The schedule calls for one round per heading per shift, or a daily total of six rounds in each section. Actually, the number has been five instead of the desired six. Principally responsible for this has been a shortage of locomotives to shift equipment from face to face according to schedule. However, time lost in haulage as the distance between headings has increased has been minimized by a progressive improvement in the overall efficiency of the crews. Where heavy ground is encountered, or when the roof and walls tend to slough, granite masonry or concrete supporting arches are constructed and spaced to meet requirements. Masonry is used only when cement for concrete cannot be obtained.

Tunneling in the 20x16-foot section at the lower end of the line is carried on in two steps. An 8x10-foot pilot bore is first driven by the method and equipment already described and is then enlarged with Ingersoll-Rand stopehamers and Jackhamers. In this full-size horseshoe-shaped section the invert will be concreted to the proposed height of the water flow. All tunnel work is scheduled to be completed by March, 1950.

Topographic conditions are such that the entrances to the adits, which are driven into mountainsides rising steeply from the Santa Eulalia Valley, must be protected against landslides. Although the region is semiarid, the runoff from occasional heavy rains sometimes dislodges boulders and precipitates an avalanche. Consequently, it is necessary to rear masonry retaining walls above and around the portals to safeguard structures and workers. Each tunnel section has an emergency escape passage for use in case the entrance should be blocked. It is in the form of a raise driven to the surface from either the adit or the tunnel and is topped by protective masonry up to 6 feet high. On one occasion the portal of No. 1 Adit was completely closed by a slide.

The Moyopampa power plant and distribution station is to be located in the river valley at the lower and southern end of the project. The powerhouse is to be a 190x120-foot concrete structure and will be large enough to accommodate the initial installation of three generators driven by twin turbines and the projected 30,000-hp. units. A 5-story control building, occupying 70x50 feet of space, will house the stores department and battery room; and administration offices will be in a separate structure. The discharge and overflow channels are under construction.

The steeply inclined penstocks will rest on stone-masonry foundations which are now being laid to receive them. A single-track service railway, with a single-drum electric cable hoist at the top for handling cars, has been carried up the mountainside and flanks the route of the 4-foot steel pipes. Structural materials for the power plant and penstocks arrive by railroad on the opposite side of the river and are transported across the stream on a bridge built by the contractor.

The surface plant for ministering to the various project needs is unusually complete because local conditions such as import and currency restrictions made it imperative that the contractor provide himself with all the facilities required to begin operations and to carry them along as they progressed. The electrical department was manned and equipped

PROTECTED PORTAL

Masonry structures and a heavy door guard the entrance to each adit against damage from landslides. At the top is an escapeway that provides an exit from below in case of emergency. The 16-inch ventilating line for the tunnel workings runs through it. The blower serving the line is shown at mid-right. This portal had been completely blocked by an avalanche, remnants of which are visible at either side.

with complete facilities for servicing and repairing motor vehicles adjoins the machine shop. Logs felled nearby are sawed into lumber which, after seasoning, goes to the carpenter shop which turns out virtually everything of wood that is required on the job. All furniture for the camps and offices was produced there, as well as forms for concrete pouring both underground and on the surface.

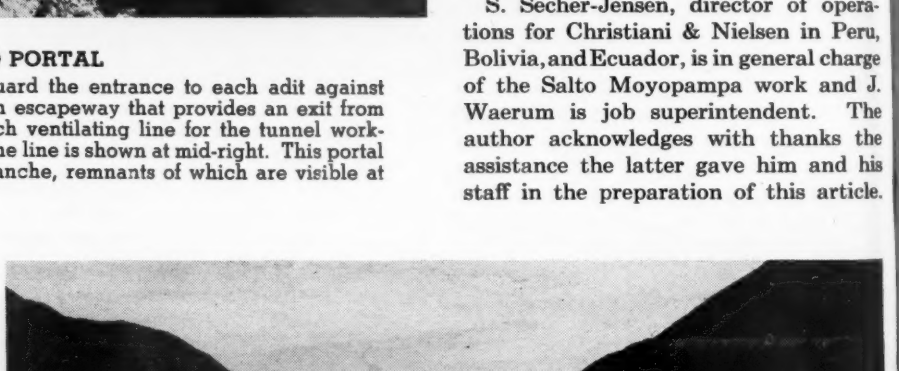
Pneumatic equipment is serviced in shops at the adit portals, and major repairs are made in a shop at the power-plant site. Drills are sent out of the tunnel sections regularly for inspection and cleaning—maintenance that saves both time and money. Sixty-five rock drills and paving breakers are in use. The drill-steel shop contains a complete line of Ingersoll-Rand equipment for reconditioning Jackbits and Jackrods and resharpens about 30,000 bits monthly. When the conversion to stud-type connections is accomplished, it is expected that handling and shop costs will be reduced.

Compressed air for the various requirements is furnished by eighteen 75-hp. Motorcompressors with a total capacity of 6300 cfm., or 350 cfm. each. Four machines at each tunnel adit supply air for the drills and mucking machine, a 4-inch delivery line being run into each heading. Two units at the powerhouse site operate Jackhamers and paving breakers utilized in excavating for that structure and for the penstocks.

S. Secher-Jensen, director of operations for Christiani & Nielsen in Peru, Bolivia, and Ecuador, is in general charge of the Salto Moyopampa work and J. Waerum is job superintendent. The author acknowledges with thanks the assistance the latter gave him and his staff in the preparation of this article.

to build and maintain the power-distribution lines throughout the working area; a telephone system with connections to all tunnel headings, stores, offices, camps, and to the power-company's network between existing generating stations and the main switchboard in Lima; and the lighting and blasting circuit into each tunnel heading. All current is drawn from a 10,000-volt transmission line that parallels the tunnel route. In addition to a 400-kva. transformer station at the portal of each adit there are several smaller substations at other locations to step down the voltage for the operation of pumps.

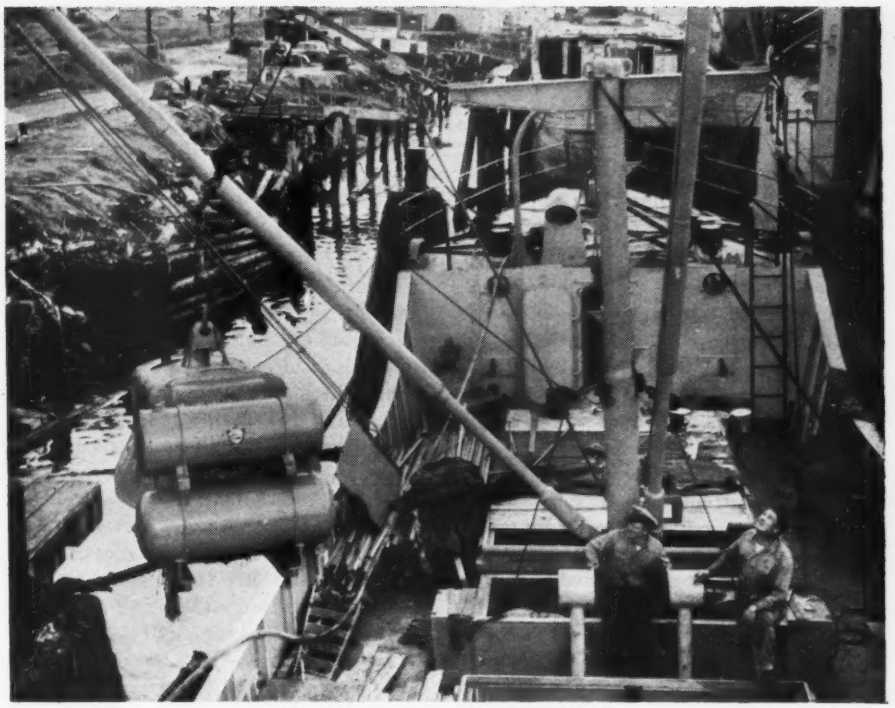
Equipment in the machine shop includes four lathes, milling and shaping machines, three drill presses, and several electric and acetylene welding outfits. Most of the ordinary parts needed for machinery repair and many other metal accessories are made there. The 16-inch pipe for ventilating the tunnel headings is fabricated in the tin shop. A garage



MAIN LABOR CAMP

Living quarters for single men, canteen, commissary, hospital, and schools are provided by the contractor. Makeshift housing in the foreground was built by married workers of materials furnished them without cost.

Treasure Hunters Again Comb Cocos Island



LOADING EXPEDITION SHIP

Skipper Charles Hale (left) and sponsor Ellis Patterson looking on as an Ingersoll-Rand portable air compressor was swung aboard their 185-foot craft "Bolivar" in the harbor at San Pedro, Calif., on January 21. Shortly afterward the boat set sail to explore Cocos Island for fabled buried pirate booty. The compressor was taken along to provide air for diving operations and also to run power tools for probing the cliffs in which some of the treasure is supposed to have been secreted more than 100 years ago.

ANOTHER search is in progress for the legendary pirate treasure of Cocos Island, a speck of land in the Pacific Ocean southwest of Costa Rica. Ellis Patterson, former lieutenant-governor of California, heads the latest expedition, which set forth on January 21 from San Pedro, Calif. If the records are anywhere near accurate, the 18-square-mile Cocos Island must be the most thoroughly scratched-over area of its size in the universe. For, according to an Associated Press report, this is the 444th attempt that has been made to find the golden trove that it supposedly harbors. That amazing total is ample evidence of the irresistible lure of the spoils of brigandage.

As the accompanying picture shows, the Patterson expedition is equipped with modern means of putting divers underwater to comb the depths for the prize that has eluded all previous parties. In addition, it carries geophysical instruments that are designed to reveal the presence of metallic objects. Mr. Patterson flew back to Los Angeles on February 23, and by that time indications of metal had already been recorded, although the material itself had not been uncovered.

The Cocos Island treasure story is perhaps the most persistent of its kind. It not only refuses to die, but even grows more alluring with the passing years. News reports of the Patterson quest estimated the value of the Cocos cache at 500 million dollars, and referred to it as the "lost loot of Lima." Actually, the origin of the supposed treasure has been ascribed to various sources. The most popular versions of the innumerable stories can be grouped under three headings.

1– Millions of dollars of coin and ingots from the Mexican Government looted in 1819-20 by Benito Bonito, a Portuguese naval captain who turned pirate. He is supposed to have hidden some of this wealth in the cliffs of Wafer Bay and also to have buried kettles of golden doubloons "in a little river that has an islet between its banks."

2– Ecclesiastical gold and gemmed altar vessels from Lima Cathedral in Peru. Legend has it that the treasure was, for some undisclosed reason, placed under the protection of a Peruvian guard aboard a British ship in Callao Harbor. The skipper, or mate, a "Captain Mary" Thompson or Thomson, is supposed to have murdered the guard, made off with the plunder, and buried it in the cliffs of Chatham Bay on Cocos Island. The vessel has been variously called the *Mary Dyer, Mary Dear, Mary Dier, Mary Read, and Mary Reid.*

3– Quantities of ingots and pieces of eight obtained from Spanish homes in Peru or Chile by the "stout buccaneer," Edward Davis, and his shipmates about 1864.

What might be considered evidence in support of the second hypothesis is the following passage reputed to have been entered in the diary of Lord Dundonald, commander of the Chilean Navy, on August 19, 1821: "Spaniards relieved the fortress at Callao and walked off unmolested with plate and money to the amount of millions of dollars; in fact, the whole wealth of Lima, which was deposited in the fortress for safety."

However, some treasure-lore researchers believe that these stories, which have been handed down for more than 100 years, should be taken with the proverbial grain of salt. One of them, Harold T. Wilkens, in his recent book *Panorama of Treasure Hunting*, goes so far as to say that the tales are pure fiction, with no substantiating facts behind them. Discussing Hypothesis No. 2, he states that no ship bearing any of the names mentioned was listed in the British Registry, nor was it known to Lloyd's. He also charges that the myth of Cocos pirate loot has been perpetuated to the point where it constitutes an organized racket. There is, he says, a "chart-faking factory" in New York City that turns out in wholesale quantities a Cocos Island map that purportedly shows just where the booty is buried. Copies are peddled surreptitiously, and there seems to be a perennial crop of gullible customers.

Notwithstanding these skeptics, and despite the absence of authenticating evidence, the Cocos Island legends continue to find many believers. If this were not so, men would not go on financing new expeditions to try again where so many have failed. One thing is certain: if there is any treasure on the island it will one day be found, or the island itself will eventually be dug away and disappear.

Kraft paper especially prepared for wrapping metal stock, parts, or equipment affected by the corrosive action of moisture is being manufactured by Nox-Rust Chemical Corporation. The paper is impregnated with a chemical that slowly vaporizes, permeating the voids in a package and, it is claimed, protecting the contents against rust. It comes in rolls or sheets up to 36 inches wide.

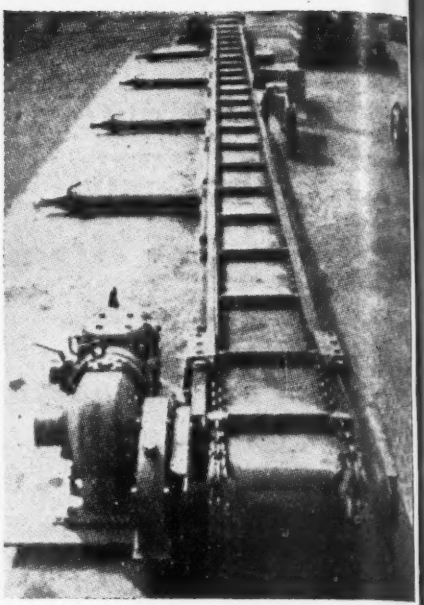
MINING COAL WITH A PLOW

RECENT changes in coal-mining machinery and methods have mechanized the industry to a high degree and eliminated much of the back-breaking toil formerly associated with it. Continuous mining—the simultaneous cutting and loading of coal without drilling and blasting—is no longer a dream but an actuality, for two machines capable of performing this work have been developed in this country during the past year. Both move under their own power to the face, cut or tear the coal from the seam, and load it into waiting shuttle cars or on to conveyors for transportation.

Some very ingenious devices to mine coal continuously also have appeared in other countries. One of the most interesting of these is a plow that was invented in Germany in 1942 by a coal-mine official. It was recently described in detail in *Iron and Coal Trades Review*, a British publication, as being a plow-shaped blade that is pulled along the working face by power winches, the coal cut or "plowed" from the seam falling directly on to a conveyor that parallels the face.

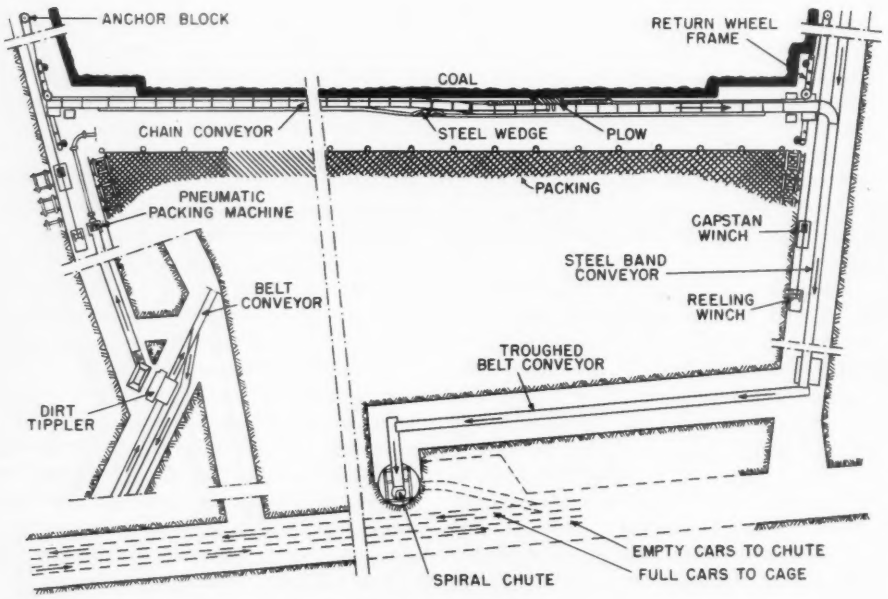
Fabricated from mild steel plate, the machine is made of two identical halves that are fastened together and can work with equal facility in either direction. The cutters have edges of hard alloy metal and are available in two sizes: 18 inches for thin seams and 28 inches for thick seams. They are bolted in place and readily detachable. Depending upon the hardness of the coal and the speed of travel, the plow can cut the equivalent of 40,000-50,000 linear feet before the blades must be removed for resharpening. Although its theoretical capacity is 2-5 tons a minute, the actual quantity mined is based on such factors as speed of the machine, hardness of the coal, and depth of cut taken. The last-named variable ranges from 4 to 12 inches.

In addition to carrying away the coal, the conveyor also supports the plow and guides it along the working face. It is made up of sections that are hinged for both vertical and horizontal movement, thus allowing the conveyor track to adjust itself to floor irregularities and to be pushed closer to the seam after a cut has been completed. In operation, each section is advanced as soon as the plow has passed, thus keeping the cutting edge biting into the coal. The mechanisms for moving the conveyor toward the face include jacks, ratchet devices, steel wedges, and compressed-air cylinders. Where jacks or pneumatic cylinders are used, they are spaced along the conveyor at 15-30 foot intervals and operated by hand. In the case of steel wedges and ratchets, the sections are automatically shifted by the plow as it passes them.



PLOW-CONVEYOR SECTION

Known as the Westfalia Lunen, this is one of the most used of the German machines. The cutting element or plow is on the right side. At the left are four compressed-air cylinders that push the whole assembly up to the face after each successive cut. Power for actuating the conveyor and for operating the cable winches that pull the plow back and forth along the coal face may be furnished by either air or electric motors.



TYPICAL MINE LAYOUT

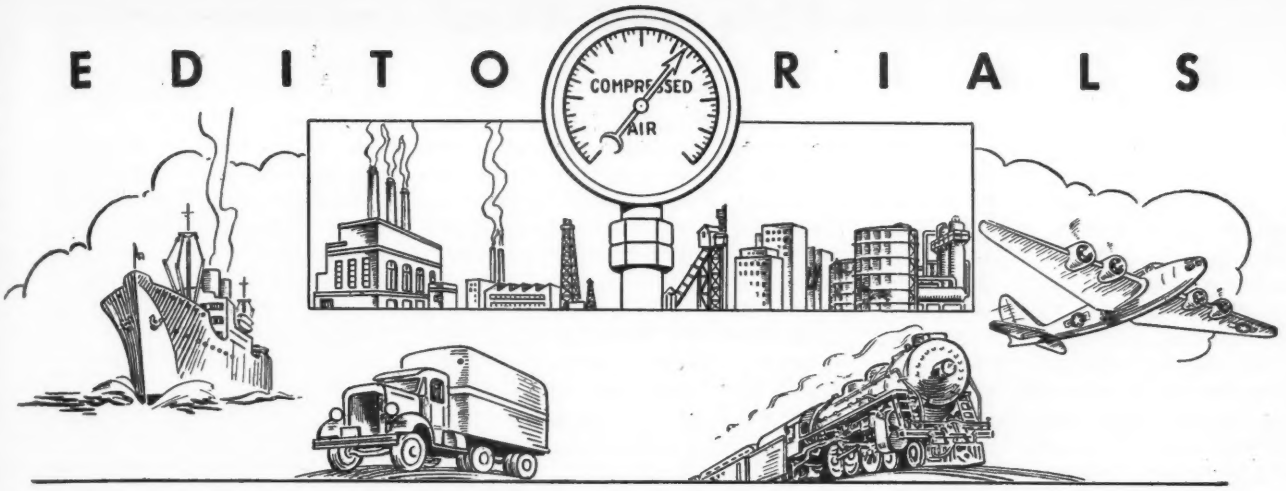
Movement of the chain conveyor toward the face after each cut is accomplished by means of a steel wedge pulled by the plow. At each end of the face being worked are two winches: one a capstan winch to pull the plow back and forth, the other a reeling winch to wind or unwind the wire rope from the capstan winch. A system of anchor blocks and return wheels enables the plow and conveyor to advance the face a considerable distance before the winches must be moved. Coal cut by the plow is delivered by conveyor system to a chute, from which it is loaded into cars on the level below. A second conveying system delivers dirt to a pneumatic packing or stowing machine that blows it into mined-out areas to prevent caving.

The coal cutter was designed for and so far has been used only in connection with the longwall method of mining. Depending upon the size and horsepower of the conveyor system, a section of face from 300 to 900 feet long can be mined at a time, the worked-out area behind the machine generally being allowed to cave, if conditions permit. Otherwise the space is filled with waste materials.

One of the many advantages claimed for the coal plow is that the unsupported width of roof is less with this type of machine than with others. A distance of 4 feet between the working face and the foremost row of props is all that is required for the track and conveyor. As posts are placed after every second cut, a distance of approximately 2 feet, there is never more than 6 feet of roof left unsupported, and that for a short time only. In addition, many German mines use special T-shaped roof bars that extend out over the conveyor and plow, offering partial support right up to the coal seam.

We are indebted to "Iron and Coal Trades Review" for both facts and illustrations.

EDITORIALS



YEAST FROM WASTE

THE paper-making industry may be on the way to solving one of its oldest public-relations problems, and profitably at that. Ever since the sulphite-pulp manufacturing process was introduced 75 years ago, waste liquors have contaminated streams and killed fish, thereby arousing the ire of the public in general and sportsmen in particular. There is a good chance that this will be ended soon and that paper mills will find themselves in the by-product yeast business.

Chemists who tackled the waste problem on behalf of twelve sulphite-pulp makers now have in operation at Rhinelander, Wis., a $500,000 commercial-size experimental plant in which the spent liquor is rendered unobjectionable and at the same time converted partially into yeast. Success of the process rests on the fact that the wood sugars, which are the offending elements in the liquor, promote the growth of certain types of yeast cells. By adding cultures of what is termed "torula" yeast, 90 percent of the sugars is removed.

In making sulphite pulp, wood chips are cooked in a calcium bisulphite solution prepared from limestone, sulphur, and water. When the residue is discharged into streams, it kills fish not because it is poisonous but because it deprives them of essential oxygen. The sugars are excellent food for various aquatic organisms, and these multiply so fast that they use up the available oxygen. The fish go elsewhere in search of this vital element, but if they are trapped behind obstructions they die. There is nothing toxic in the liquor.

Various methods of rendering the waste solution harmless or of disposing of it have previously been tried without success. The yeast project was started in 1943, progressed to the pilot-plant stage two years later, and the Rhinelander plant began operating last November. In it, the spent liquor passes to a large propagating vat, where the yeast cultures are added along with a small quantity of a fertilizing salts solution. The yeast drains in liquid form from the bottom of the vat and dries into a yellowish powder rich in B vitamin complex and containing proteins.

Numerous technical difficulties have yet to be overcome to warrant the large expenditures pulp mills will have to make to provide their own treating facilities. The need of establishing a market for all the yeast also remains. That which has been turned out at Rhinelander has gone into poultry feed. It brings around ten cents a pound, which is less than the cost of production, and not all of it finds a buyer. It is believed, however, that the yeast will be put to additional uses as a food element for livestock and humans. Data so far available indicate that a plant for a mill making 100 tons of pulp a day will cost around $1,000,000 and yield about 20,000 pounds of dried yeast daily.

EMACIATED DOLLARS

IF A MAN has more money in the bank now than he had a few years ago, is he richer than he was then? There was a time when no one would have hesitated to answer such a query in the affirmative, but people are a little doubtful about that today. The reason therefore is that something has happened to our economic setup, or perhaps we should say something has happened to upset our economy. That something is called inflation. Money still talks, but it has lost much of its voice. As we survey prevailing prices for things we must buy, the dollar seems to speak hardly above a whisper, and small change has become virtually inaudible.

A good many persons seem to think that a corporation's dollars are bigger than the ones they get hold of. That, of course, is not so. This is the season when industrial concerns are reporting to their stockholders on the results of last year's business, and many of these summaries contain references to illusory statistics. Managements are pointing out to security owners that "All is not gold that glistens." It is true, they agree, that 1948 profits appear to have been large in comparison with those of former years. However, they point out that such comparisons don't mean much because the measuring stick has meanwhile been shortened.

The report to du Pont stockholders contains the following reflections on the subject by C.H. Greenewalt, company president: "It has been argued that post-war profits have been too large—and that profit margins should be reduced through taxation or other methods of redistribution. This point of view largely disregards the fact that the highest production volume in the history of the country should naturally lead to increased profits. It further ignores the fact that inflation has reduced the purchasing power of the dollar to about half that of prewar. Most important of all, it disregards the basic importance of adequate profits to the growth and development of the American economy.

"The principal function of industrial enterprises is the production of needed goods and services in ever-increasing abundance and variety, and at ever-decreasing costs. This objective can be achieved only if managements can function with such efficiency in a competitive economy as to yield a profit adequate to those who have supplied the capital and sufficient to encourage further growth and development. Profit, therefore, is the incentive which engenders thrift and, through thrift, the investment of savings in the tools of production without which our entire economy would come to a halt. Adequate profits should be a cause for commendation—not censure . . . .

"It is the return on investment which determines whether or not capital will be left in the business and new capital obtained for expansion, development, and improved services. The company believes that its profits over the years . . . have provided greater job opportunities and security for workers, have furnished customers more and better products, and have helped to improve the American standard of living."

This and That

Safety Research Laboratory

A research laboratory, planned expressly for furthering the development of safety devices and equipment for all branches of industry is to be built at Pittsburgh, Pa., by the Mine Safety Appliances Company, which manufactures 3000 articles for safeguarding life and property. The establishment's facilities will be made available to all industries, and its activities will be coordinated with those of the U.S. Bureau of Mines, U.S. Public Health Service, and universities. The 4-story structure will contain equipment and instruments running the full range of the various divisions of science and will also include a wind tunnel that is designed to improve existing devices for measuring air velocities in mine shafts and in underground workings.

★ ★ ★

Pulp Fiber Chairs

The Armour Research Foundation, of Chicago, Ill., is reported to have developed a process for making a one-piece back and seat for chairs from wood pulp. After being broken down in a beater, as is done in manufacturing paper, the pulp is placed in a felting tank and diluted with water. The felt fibers are then drawn by suction to a die shaped like a chair back and seat and covered with a fine screen. After the material is built up to the desired thickness, the die is removed from the tank and the fiber accumulation separated from the screen by means of compressed air. The mat, called a preform, is next dipped in a resinous solution until it is saturated and is then oven-cured. If a smoother finish is desired, the preform can be subjected to pressure and heat in a hydraulic molding press. The product becomes a chair by screwing on to it a one-piece leg assembly. It is claimed that the new technique can also be applied to making other types of furniture such as tables and drawers. Since the process is entirely automatic, it has possibilities of mass production at low cost.

★ ★ ★

Sets New Diving Record

Standing in ten feet of water in a pressurized tank at Washington, D.C., on March 4, Harold Weisbrodt, of Chicago, Ill., a boatswain's mate in the U.S. Navy, simulated a dive equivalent to a submergence of 561 feet, thus establishing a record. Wearing a 235-pound suit, Weisbrodt spent 90 seconds at a maximum pressure of 264.6 psi., which was applied on the water by means of compressed air. The previous record made under simulated conditions was a mark of 550 feet set by Jack Browne, a civilian, in April, 1945, at Milwaukee, Wis. The British Royal Navy claims the deepest submergence in open water for one of its men, who made a descent of 536 feet in a Scottish lake. Two U.S. Navy divers, Wesley Singleton and George McCullough, went down 485 feet off Key West, Fla., in 1948.

★ ★ ★

More Coulee Power

Contracts were awarded last month for the last three of the eighteen generator sets scheduled for the Grand Coulee Dam powerhouses on the Columbia River in the State of Washington. When they begin to function in 1952, Grand Coulee will be the world's greatest power producer, with a rated capacity of 1,974,000 kw. When sufficient water is available to operate the units above their ratings, output may reach 2,200,000 kw. for considerable periods. This just about equals the consumption of electricity of Philadelphia and Detroit combined. Nine generators in the left station are now in service. The first unit in the right powerhouse will be put in operation this spring, with three more to follow in each of the two next years and the final two in 1952. Rapid growth of population and industry in the Pacific Northwest since the war has created a power shortage that the present Grand Coulee facilities cannot meet, and even the output of two small generators intended solely for station use is being sold. The Shipshaw development in Canada, with a continuous production of 1,500,000 kw. from two plants, is currently the largest individual source of electric energy. Hoover Dam, with an ultimate capacity of 1,835,000 kw., can now turn out 1,420,000 kw.

"Better shake a leg mister. There's liable to be a bridge constructed here soon."

★ ★ ★

Fast Dam Work

This heading would mean the same thing if read in reverse order. It refers to the completion of the Jackson Gulch Dam in Colorado in less than half the time allotted by the U.S. Bureau of Reclamation. The Vinnell Company of Alhambra, Calif., took a $1,925,904.50 contract on April 17, 1947, to build a 181-foot-high, rock-filled structure on the Mancos River in 1150 days. Actually, it finished the work, along with inlet and outlet canals, in 567 days. Secretary of the Interior J. A. Krug characterized this performance as "a highlight in Reclamation's 46-year-old history." The dam will impound 10,000 acre-feet of water for release late in the growing season when the flow is not sufficient to irrigate croplands.

Since 1876, Mancos Valley ranchers have been diverting the river water through ditches. By 1893 there was so much land under cultivation that there was not enough to go around at the end of the summer when stream flow is low. Local irrigation organizations built two small reservoirs, but they gave only partial relief, so the Bureau of Reclamation came to their aid. The National Park Service will take some water from the new reservoir to serve domestic needs in Mesa Verde National Park. That area is so devoid of moisture that even drinking water has had to be brought in by pack horses.

★ ★ ★

Bridge Awaits River

Army Engineers have erected on dry land near Courtney, Mo., an 1884-foot-long steel bridge under which the Missouri will flow before long. It is part of a project designed to eliminate a 6-mile hairpin loop in the river, known as Liberty Bend, which traps floating ice and builds up flood pressure every year. A channel has been dredged under the new bridge, with enough earth left in place at its upstream end to keep the Missouri in its present course for the time being. Sometime this spring, the retaining plug will be blasted away and that stretch of the river will be straightened out. The construction cost is $4,200,000.

New Compound Hardens Steel by Simple Treatment

A NEW compound for hardening steel, called "Hi-Speed-It," is surprisingly effective, according to the manufacturer's claims. With it, it is stated, any ferrous metal can be hardened to a considerable depth by a simple treatment that requires nothing more than a few minutes of time and only a plumber's torch or an open forge or furnace in the way of equipment.

"Ordinary wire nails and common reinforcing rods hardened in this new way can," it is reported, "be driven through tough automobile spring leaf with no apparent dulling. Dimestore chisels become so hard they cut nicks in chrome-manganese railway rails. In a recent test before engineers of a large railroad, a 1½-inch gouge was hardened in three minutes. When it was put in a pneumatic hammer it cut, without stopping, four strips 5/16 inch deep, 3/8 inch wide, and 14 inches long from a piece of No. 302 stainless steel. A 3/16-inch carbon-steel drill was hardened in 32 seconds and drilled a clean hole in a ¼-inch-thick piece of 25 chrome-20 nickel steel. It is not necessary to reharden tools before sharpening them again."

The compound, a gray powder, is applied to low-carbon steel by heating it to cherry-red and dipping or rolling it in the powder. In from 15 to 30 seconds the material fuses and forms a crust, after which the object is again dipped in or sprinkled with the powder. After reheating to cherry-red, it is quenched in clean, cold water or brine. Increased depth of hardening is obtained by repeating the steps preceding quenching. Articles of high-speed steel are processed in a similar manner but at higher temperatures, and they are quenched in oil.

The compound was developed by Sam Necamp of New York City. In its original form, it was used during the war for hardening rifle barrels and is reported to have given good results. However, it was so expensive to produce that it sold for around $300 a pound. In an effort to bring the price within commercial range, Necamp has continued to experiment with modified formulas and now has a product that retails for $14 a pound. It is manufactured and distributed by Wilson Carbon Company, Inc., 60 East 42nd Street, New York 17, N.Y.

Joints in Concrete Runways Resealed by Special Equipment

GIVEN a contract to clean out and refill 10 miles of joints in the concrete runways of the Naval Air Station at Atlanta, Ga., the Ledbetter-Johnson Company set about designing five pieces of portable equipment that would simplify the work and do it quickly. In the order of their use they are: a hydraulically controlled chisel or plow, a mechanically operated wire brush, a compressed-air blower, a heating tank, and a pressure-type applicator.

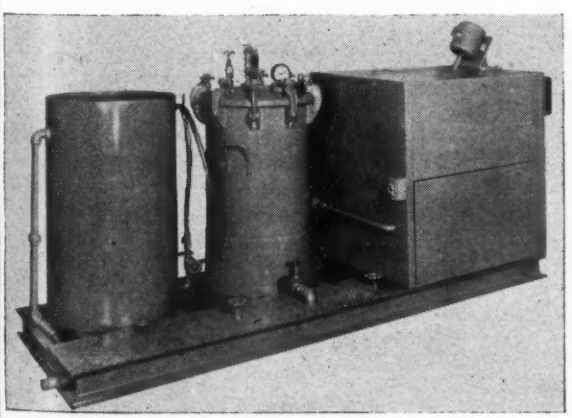
Two men handled the plow, which is mounted on four wheels with pneumatic tires. One walked behind and controlled the power unit, while the other, seated at the back, operated the chisel that removed the heavy cohesive compound with which the joints had been filled. Close on the heels followed a worker who pushed along the rotary brush that swept out the loosened material. To do a thorough cleaning job, to soften sealing compound still clinging to the concrete, and to dry the joints, there was a 2-wheeled kerosene blowtorch that heated and delivered a blast of air supplied by a portable compressor through a hose connection.

A rubber-type material was used to refill the joints and was reduced to a fluid state in an oil-jacketed heating tank maintained by thermostat at a temperature of 350-400°F. From there it was poured into the applicator, also oil-jacketed and having a capacity of 100 pounds. The operator of this unit walked backward as he pulled it along, thus enabling him to keep an eye on alignment and on the stream of hot sealing compound issuing from a valve-controlled nozzle at a pressure of 9 psi. By means of these improvised facilities the work was done at the rate of seven cents a linear foot.

Sealing Pressure Castings by Production Method

MORE than three years of development has gone into a combination vacuum and pressure unit built by the Metallizing Company of America to impregnate porous castings on a volume basis to cut the cost of the work. Called Mogullizer, it uses a special metallic sealing solution and will take a casting up to 18 inches wide and 28 inches long, or a number of smaller ones of like volume. The assembly consists of a 54-gallon supply tank provided with two electric heating elements and an agitator, of a vacuum pump, of a pressure vessel, and of a cylindrical rinsing tank with city water-supply and drain connections.

The sealing solution—Mogul Cast Seal Type B—is mixed with an equal quantity of water and is heated and maintained at a temperature of 190°F. by thermostatic control. Meanwhile, a vacuum is pulled and held on the work in the pressure vessel. When this is broken, the impregnating fluid is introduced and forced into the evacuated pores of the castings with air at a pressure of 90 psi. After a period of fifteen minutes the air is released, the solution is returned to the supply tank, and the work is transferred to the rinsing tank from which it emerges, it is claimed, with no trace of Cast Seal clinging to it. The company is currently offering to impregnate sample castings at no cost so that interested persons can determine whether the results meet requirements.



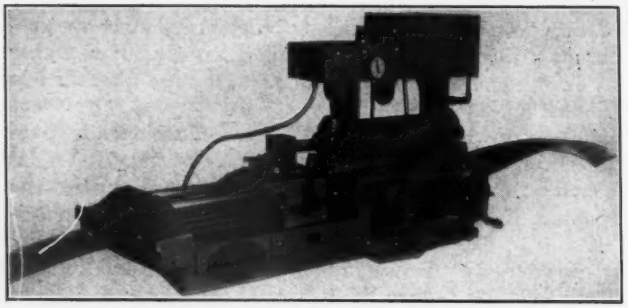
MOGULLIZER

The units, from right to left, are: 54-gallon solution tank with heating elements and agitator driven by a 1/3-hp. motor, all mounted on top of vacuum-pump compartment; pressure vessel in which castings are evacuated and sealed; and rinse tank. A hoist traveling on a runway over the assembly facilitates operations.

Driller's Invention May Save Millions

A VETERAN diamond-drill runner employed by the U.S. Bureau of Reclamation, E.D. Rhoads, has invented a simple packing device that permits sealing off each of several watercourses penetrated by a drill hole and measuring their respective depths and volumes of flow by means of tubing run to the surface. Previously it has been necessary to drill a separate hole to investigate each water horizon encountered in foundation exploration work. Engineers of the Bureau think the device will save a million dollars in drilling costs just on dams it has scheduled for construction. Rhoads received a $1000 prize from the Government on March 16 for his innovation.

Industrial Notes



A self-contained slide feed for strip stock suitable for use with fabricating machines has been announced by U. S. Tool Company, Inc. The unit has a built-in pneumatic cylinder that eliminates mechanical press connections and permits moving it from one machine to another. It may be operated semiautomatically or made fully automatic by incorporating interlocking switches. By varying the number of piston strokes and timing the slide to coincide with the press cycle, stock of any desired length may be fed with an accuracy, it is claimed, of 0.002 inch. The reciprocating head of the unit rides on guide rods and has a Stellite blade that grips the work and carries it forward—backward movement of the strip when the head reverses being prevented by a pair of rolls with a one-way clutch. Straightener rolls may be used if desired to take material from a coil. The slide is at present available in one size for stock up to 12 inches wide and for a maximum pitch of 12 inches at each feed stroke.

At the beginning of this year, the National Bureau of Standards began using the definitions of the International Temperature Scale of 1948 both in its own research program and in calibrating instruments for other scientific and industrial purposes. The new scale is based on a draft prepared by members of the bureau's staff and adopted at Paris by the Ninth General Conference on Weights and Measures held last October. This is the first revision of the International Temperature Scale since it was established 21 years ago. The experimental procedures by which the scale is to be realized are substantially unchanged; but certain refinements, based upon experience, have been incorporated to make the scale more uniform and reproducible.

Research work carried on over a protracted period has culminated in the production on a commercial scale of absolute alcohol (200 proof) at a cost no greater than that of making the industrial grade, according to a paper by Dr. Donald F. Othmer, head of the Department of Chemical Engineering at the Brooklyn Polytechnic Institute. This is accomplished by a new method of distillation and the development of equipment in which vacuum-distilled ether in combination with pressure is used to remove the last trace of water from the product. Pure alcohol is required for pharmaceutical purposes, and is in increasing demand as a solvent by the plastics industry. A number of plants for its manufacture has been built by the Vulcan Copper & Supply Company, which sponsored the investigations.

A nonelectric magnetic pulley for the separation of ferrous and less magnetic particles from nonferrous substances ranging from 10 to 200 mesh has been announced by the Eriez Manufacturing Company. Called the Puri-Pulley, it is designed for use as a head pulley in a belt conveying system and concentrates its strength close to the face plate. At one inch from the pulley's surface the magnetic field is said to be three times as strong as that of the standard type built for the removal of ordinary tramp iron. The added power, together with an increased effective cleaning surface, is the result of modifications in design and the use of alnico, an alloy containing iron, aluminum, nickel, and cobalt. The pulley is suitable for extracting fines from such materials as talcs, powders, chemicals, ball clays, sands for glass making, granulated rubber, and other materials that have to be of high purity. The unit is made in 18- and 24-inch diameters and in 12- to 60-inch belt lengths.

To give warning of a drop in low-pressure air below a predetermined safe point is the object of a device that was invented by Airlarm, a Houston, Tex., company, primarily for oil-field service. The alarm consists essentially of a valve element that opens automatically when the line pressure falls below the level that permits operating equipment with safety. The escaping air blows a whistle, which is an integral part of the assembly. It continues its warning blast as long as the pressure is lower than that for which the valve is set. Once pressure is restored, the shrill sound ceases. The unit

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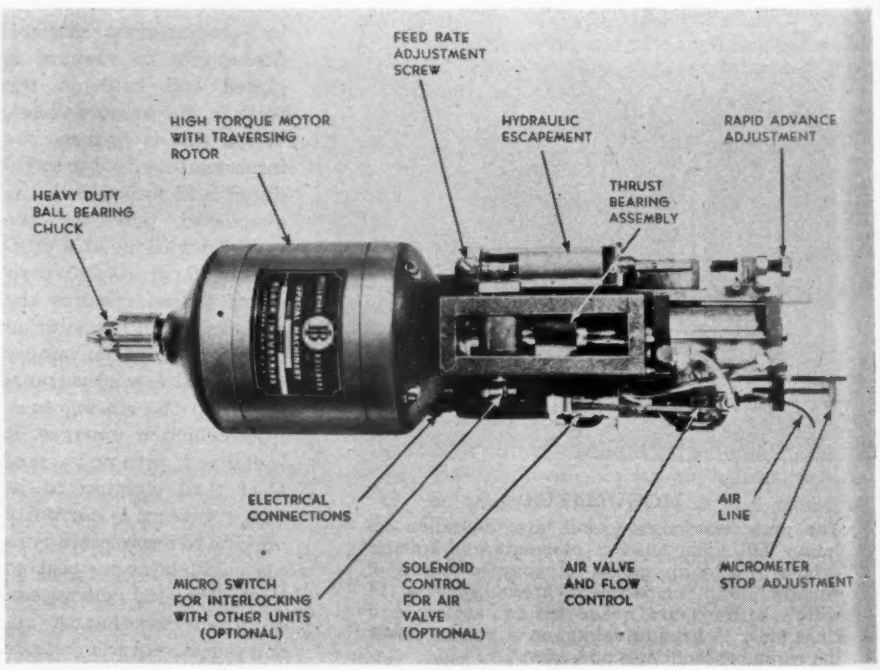
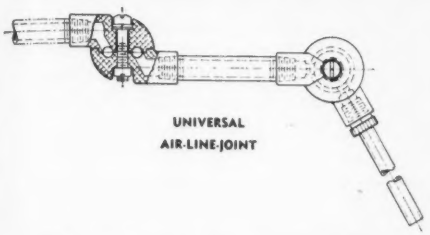
A power drilling unit based on a new principle and featuring a single rotating member is being offered by Black Industries for operations such as drilling, tapping, chamfering, reaming, counterboring, tube facing or flaring, etc. The shaft of the traversing motor is the work spindle around which torque is applied evenly because it is an integral part of the rotor. According to the manufacturer, the construction allows virtually no end play, makes for more accurate drilling, and appreciably increases drill life. A built-in pneumatic cylinder provides shockless advance to the work, at which point hydraulic control takes over until the operating cycle is completed. Feed is said to be constant even when breaking through, and a micrometer stop insures depth-drilling accuracy to within 0.001 inch. Standard units from ¼ to 1 hp. are available and will operate in any position. The illustration shows a unit with part of the housing removed.


FEED RATE ADJUSTMENT SCREW
HIGH TORQUE MOTOR WITH TRAVERSING ROTOR
HYDRAULIC ESCAPEMENT
RAPID ADVANCE ADJUSTMENT
HEAVY DUTY BALL BEARING CHUCK
THRUST BEARING ASSEMBLY
ELECTRICAL CONNECTIONS
AIR LINE
MICRO SWITCH FOR INTERLOCKING WITH OTHER UNITS (OPTIONAL)
SOLENOID CONTROL FOR AIR VALVE (OPTIONAL)
AIR VALVE AND FLOW CONTROL
MICROMETER STOP ADJUSTMENT

is called Airlarm, and is suitable for all industrial applications where pressure must be maintained above a given point.

A Universal Air-Line Joint that was originally designed to expel chips from the die cavity of a die-sinking machine and to keep layout lines on the dies visible to the operator is suitable for service wherever it is necessary to direct a jet of liquid or air on any point or piece



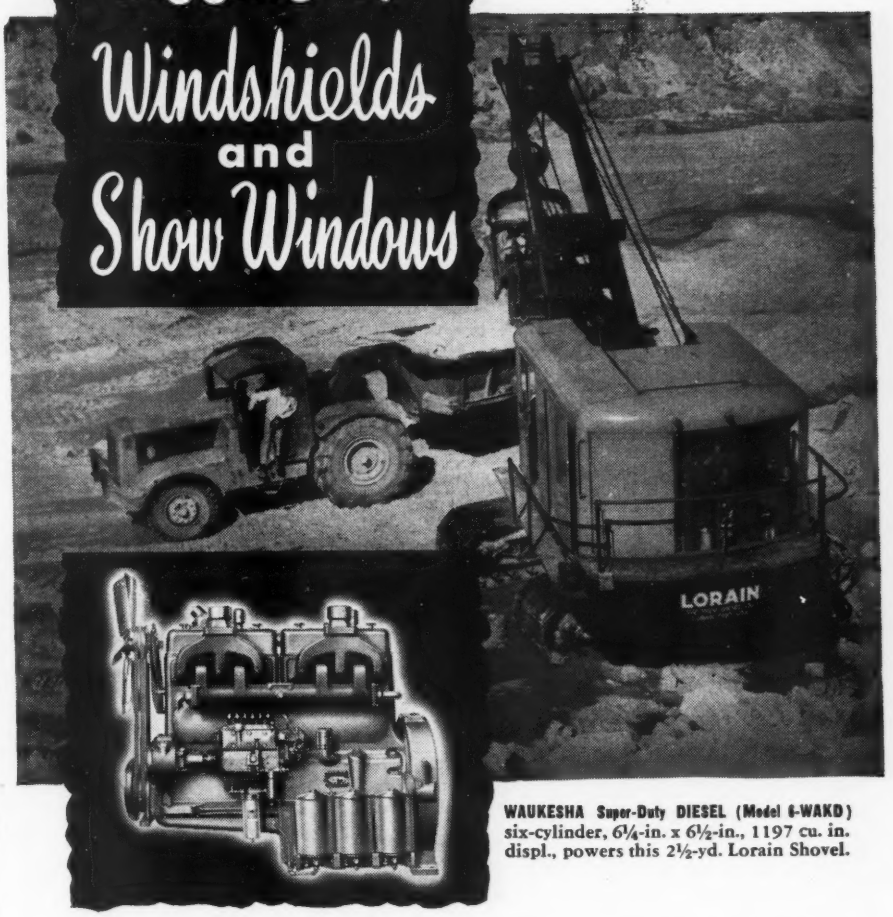
of work in a machining operation. It eliminates makeshift semirigid tubing or pipe-fitting assemblies that require frequent adjustment because of changes in position through vibration. It is claimed that the joint remains immobile and swivels the full 360°. Made of aluminum, it weighs 3½ ounces and can be used either with a liquid coolant or with compressed air on saws, screw machines, lathes, milling machines, die filters, etc. It is a product of the Universal Air-Line-Joint Mfg. Company.

Balls of nylon are said to be suitable for bearing applications where it is impossible or impracticable to lubricate, and are also recommended for ball check valves and other spherical parts that must retain their shape and be highly resistant to wear. They are machined from bar stock made by Polymer Corporation in diameters ranging from 0.1 inch to 2¾ inches and in lengths from 6 inches to 8 feet.

Dipping plated steel in a solution of an alkaline salt and water heated to a temperature of 160-180°F. removes coatings of zinc, nickel, copper, cadmium, and silver without attacking the steel. That is the claim made for Metal Stripper recently put on the market by Enthone, Inc. Depending upon the concentration and the temperature, removal is effected at the rate of 0.0002 to 0.001 inch per hour. Only an acid dip is normally required for replating.

Air at a maximum pressure of 50 psi. performs a threefold service in a new metal-parts washing machine made by Magnus Chemical Company. It agitates the cleaning solution; rocks a screen platform on which the work is suspended near the bottom of the immersion chamber; and adds force to the rinse water, which is applied by a spray gun. The equipment, called Krazy Dip, consists of a main housing that is filled with 60 gallons to a depth of 18 inches and of

digging up
Windshields
and
Show Windows



WAUKESHA Super-Duty DIESEL (Model 6-WAKD) six-cylinder, 6¼-in. x 6½-in., 1197 cu. in. displ., powers this 2½-yd. Lorain Shovel.

● You don't just dig up windshields and show windows off hand. You have to dig silica sand for the glass first. That takes a shovel like this 2½-yd. Lorain owned by the Silica Sand Co., Birmingham, Mich. It's a big-biting, deep-digging, speed shovel — with a Waukesha Diesel that is power-packed to pass the pay dirt and keep those dump trucks coming and going!

Neither dust, nor dirt, nor digging fazes the Waukesha Super-Duty Diesel. It's rugged—and protected. Remarkably responsive, too. Lively but smooth and shudder-free. And clean burning, with high fuel economy. Its unique, patented combustion chamber, spherical in shape, and the two swirl cups in piston crown, give moderate peak pressures and complete as well as clean burning—for high efficiency at all times within the engine's rated load and speed.

Hard wet cylinder sleeves, hardened crankshaft with precision bearings, simple overhead valve mechanism, gear-driven water pump cooling, and pressure oiling—all the features that make it easy to understand and simple to service. Get the whole story in Bulletin 1415.

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a small tank on one side and a platform on the other. It has a maximum load capacity of 250 pounds. The solution is used cold and removes dirt, grease, and carbon deposits.

For road jobs that are remote from sources of supply and that do not warrant permanent installations there is now available a portable asphalt paving plant with an hourly capacity of 30 to 40 tons of bituminized aggregate. It travels on pneumatic-tired wheels and is provided with four patented jack legs that anchor it and raise it to its full working height. Madsen Iron Works, Inc., the builder, says the plant can be used to advantage on jobs requiring as little as 1500 and as much as 10,000 tons of material.

Pangborn has announced an addition to its line of blast-cleaning equipment—the Hydro-Finish—that is designed to apply abrasives suspended in a liquid. The cabinet is watertight and is provided with a hopper tank for mixing, storing, and re-collecting the solids. A circulating pump delivers the mixture to the blasting nozzle, at which point compressed air is introduced to give it velocity. By varying the size and hardness of the particles, liquid-abrasive ratio, pressure of the air, and distance of the gun from the work, it is possible to clean and give a wide range of finishes to both delicate and sturdy parts. It is claimed that the

process can be used to advantage for deburring; removing directional grinding lines, heat-treat scale, and discoloration; preparing surfaces for electroplating, painting, and enameling; in the manufacture and maintenance of dies and molds; finishing threaded sections and cutting tools; and for cleaning precision machine parts.

Industrial Literature

The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y., has published two booklets which will be sent to interested persons. The first, entitled *How to Get Longer Service from Your Pumps*, discusses four factors that affect pump life and performance: corrosion, corrosion fatigue, erosion, and wear. The second—*Corrosion by Concentration Cells*—explains the causes of galvanic-cell corrosion and lists ways of combating it.

Johns-Manville, 22 East 40th Street, New York 16, N.Y., has available for distribution literature covering three new products. Two are refractories capable of standing up under temperatures as high as 3000°F. They may be used for gunning, for patching, or for casting special shapes. The third is a rock-cork felt-sided material designed especially for insulating roofs. Technical data, physical properties, and recommended applications are given for all three products.

Vari-Pitch Speed Changers is the title of a bulletin recently prepared by Allis-Chalmers Manufacturing Company, South 70th Street, Milwaukee, Wis. The changers are used with combinations of V-belts and sheaves to achieve a smooth, stepless speed range equal in some cases to 375 percent of the input speed. Twelve sizes from 1 to 75 hp. are available for use with metal-working machines, lathes, cutters, motors, refrigerator compressors, separators, kilns, conveyors, and similar equipment.

Pertinent information on the patenting of inventions is contained in two books recently published by Research Press, Inc. The author of both is Harry Aubrey Toulmin, Jr., a corporation lawyer who has had wide experience in this field. *How to Keep Invention Records* lists methods by which an inventor may safeguard his rights. *Patent Law for the Executive and Engineer* is a practical manual that presents the basic facts on patents and patent law. Books may be obtained from the publisher, 137 North Perry Street, Dayton 2, Ohio. Price, $2.50 and $2.95, respectively.

Bulletin GEA-5254 issued by General Electric Company describes its new smoke-density indicator and controller. Consisting of a light source, a phototube holder, a controlling element, and an indicator calibrated in Ringleman units, the device operates a blower to force heated air into the firebox whenever the density of the smoke exceeds a predetermined level. In addition to enabling industrial plants to comply with local smoke-abatement ordinances, the equipment is said to improve boiler efficiency by causing more complete fuel combustion. Copies of the bulletin may be obtained by writing to the company at Schenectady 5, N.Y.

Air Tools and Compressors for Railroad Maintenance of Way is the title of a 16-page bulletin published by Ingersoll-Rand Company. Among the tools described and illustrated are tie tampers, spike drivers, wood borers, impact wrenches, grinders, wire-brush machines, chipping and scaling hammers, riveters, and rivet busters. Compressors covered include portable rail- and crawler-mounted models in a variety of sizes and capacities, also the company's new Spot-Air, a gasoline engine-powered machine of the radial type that is small enough to be carried by hand or provided with a wheelbarrow-type mounting. Copies of Form 5021-A may be obtained from the company at 11 Broadway, New York 4, N.Y., or any of its branches.

HOW YOU SAVE,
Getting Drier Compressed Air

● Direct saving in the cost of cooling water saves the price of the Niagara Aero After Cooler (for compressed air or gas) in less than two years.

Extra, for no cost, the drier air gives you a better operation and lower costs in the use of all air-operated tools and machines, paint spraying, sand blasting or moisture-free air cleaning. Water saving also means less expense for piping, pumping, water treatment and water disposal, or you get the use of water elsewhere in your plant where it may be badly needed.

Niagara Aero After Cooler assures all these benefits because it cools compressed air or gas below the temperature of the surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air thru a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter by the Niagara Balanced Wet Bulb Control.

Write for complete information; ask for Bulletin No. 98

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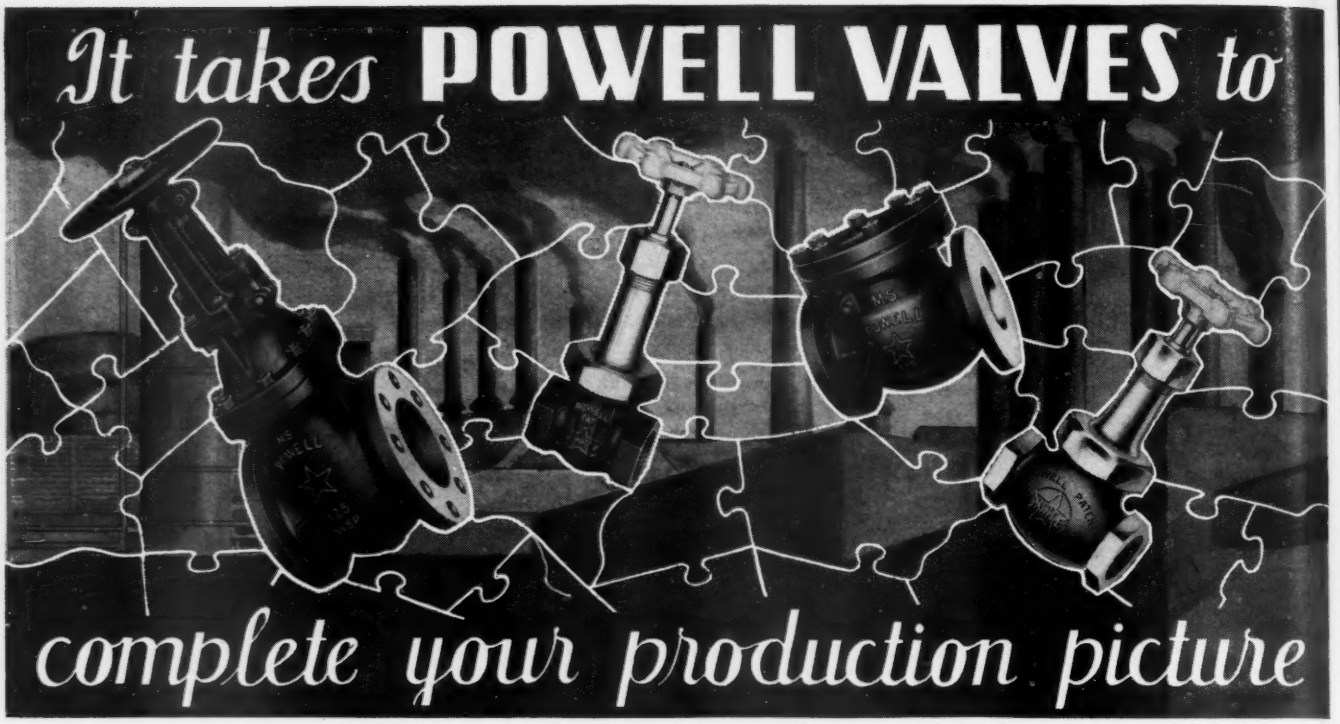


Everyone knows that in putting together a jig-saw puzzle picture it's simply a matter of putting the right piece in the right place.

In the case of flow control equipment the principle is the same. Because, only by installing the right valve—in design and material—to meet all the requirements of a specific service, can failures due to misapplication be eliminated.

Fortunately Powell *has been* applying this principle for more than a century. The result is a line of valves which is so complete that, for any set of flow control conditions encountered today, there's a Powell Valve that exactly fits all requirements.

So why not let Powell Engineers help you to complete your production picture by selecting valves that are specifically designed for your individual flow control services. Write us for details.

Fig. 95—Bronze Dash Pot Check Valve for 200 pounds air working pressure. Designed for air compressor service. Has screwed ends, screwed-on cap and regrindable, renewable, wear-resisting bronze disc. Cushioning effect of plunger in dash pot makes seating of disc practically noiseless.

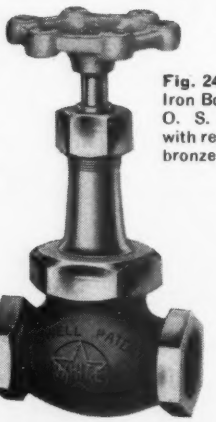
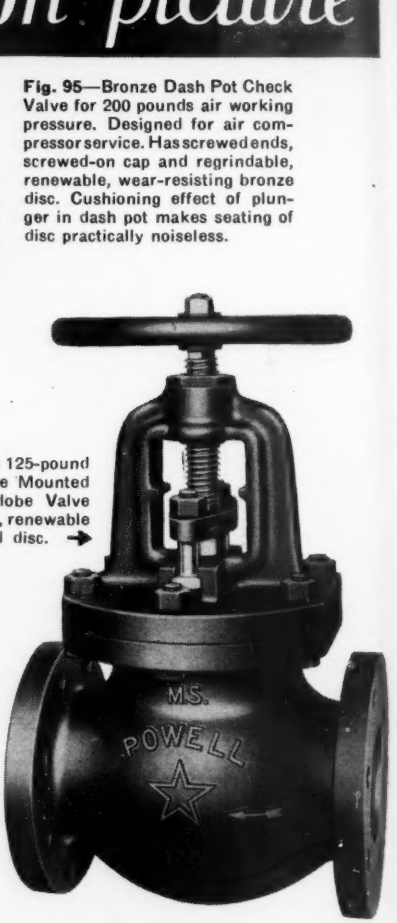


Fig. 1708—200-pound Bronze Globe Valve with renewable stainless steel seat and regrindable, renewable "Powellium" nickel-bronze disc.

Fig. 241—Large 125-pound Iron Body Bronze Mounted O. S. & Y. Globe Valve with regrindable, renewable bronze seat and disc. →



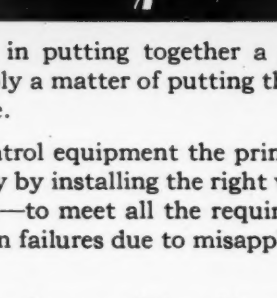


Fig. 560—200-pound Bronze Regrinding Horizontal Swing Check Valve. Screwed ends, screwed-on cap and regrindable, renewable bronze disc.

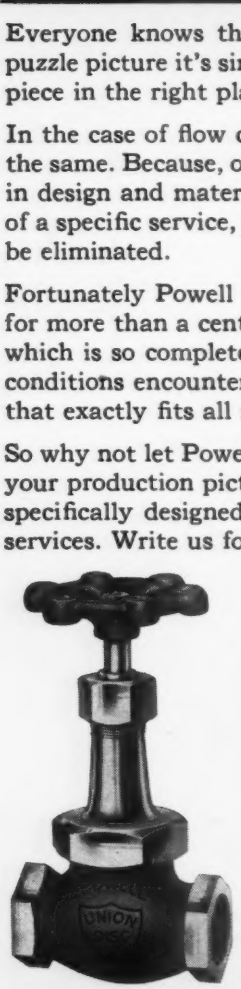


Fig. 150—150-pound Bronze Globe Valve with screwed ends, union bonnet and renewable composition disc.

The Wm. Powell Company, Cincinnati 22, Ohio

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POWELL VALVES